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The adoption of three new rail sections and specifications for carbon and heat-treated angle bars within five minutes after their presentation and without any discussion or objections from the floor of the convention yesterday afternoon illustrated the well-oiled machinery within the Rail Committee. Including within its members nearly all the leading authorities on rail matters within the association, it was evident the differences of opinion were all adjusted before the report was presented to the convention. These recommendations were adopted with as little commotion as if they referred to only a minor change in wording of some specification.

A Well Organized Committee

In view of the continually increasing cost of wooden cross ties and the resulting agitation for the substitution of ties of other materials, the Tie Committee is performing a valuable service in compiling information from year to year regarding the design and the service results secured from the numerous experimental installations of substitute ties. Not only is this report of value because of the information given concerning the particular designs referred to, but a study of the different failures reported reveals many points to be avoided in later designs. The duty of the subcommittee on Substitute Ties is not to attempt the design of a tie, but rather to observe the results secured with the many designs already in service. The report this year is of more than usual value, as it contains an index to the reports made previously on the various substitute ties, enabling one to ascertain the history of any special tie in so far as the committee has reported on it. It is to be hoped that this index as well as the report will be continued from year to year.

Reports on Substitute Ties

It is axiomatic that water is the greatest enemy of track and that most of the ills from which a track suffers are the result of an excess of moisture. At the same time it is only in recent years that it has been considered advisable to increase the expenditure for original construction to eliminate future water trouble. In many cases the funds for these increasing expenditures have not been available previously. One of the subjects on which the Roadway Committee reported yesterday was "The Prevention or Cure of Water Pockets in the Roadbed," and it mentioned several precautions which may be taken to prevent them. Closely connected with this same subject is that of sodding of slopes to prevent the washing down of the embankment material into the drainage ditches. The Roadway Committee also reported on this, describing the practices of a number of roads and presenting specifications for this work. While relatively expensive, the sodding of embankments is becoming more general at those points where trouble is expected and many instances may be cited where such precautions have saved their first cost many times over in reduced maintenance expenditures, all of which shows that we are gradually adopting higher standards and building more permanently for the future.

The Importance of Drainage

Robert Trimble, who was elected president of the American Railway Engineering Association, is chief engineer maintenance of way of the Pennsylvania Lines West of Pittsburgh, Northwest System, with office at Pittsburgh, Pa. Mr. Trimble was born at Butler, Pa., and was educated at the Western University of Pennsylvania during the years 1872 to 1875. He entered railway service in the latter year as chainman for the Pennsylvania Company, and until 1903 occupied various positions in the engineering department, including that of principal assistant engineer. In 1903 he was appointed chief engineer maintenance of way, which position he still holds. Like most Pennsylvania officers, his entire service has been with that one road. A very interesting piece of information in connection with Mr. Trimble's career is the fact that he was the resident engineer in charge of construction of the present Union Station at Chicago, which was completed and put in service on April 4, 1881. Thomas Rodd, who is now chief engineer of the Pennsylvania Lines West of Pittsburgh, was then principal assistant engineer. Mr. Rodd is now chief engineer of the Union Station Company, which is about to replace the present structure with a magnificent new one, and Mr. Trimble is the chairman of the board of advisory engi-

President Robert Trimble

neers, to which has been committed the study and supervision of certain of the construction features in connection with the work. Mr. Trimble has been first vice-president of the Association during the past year, and during the previous year was second vice-president.

An Increasing Knowledge of Paint

Not many years ago the railways bought their paints almost entirely on the recommendations and reputations of the manufacturers. This condition existed because the paints were all mixed by secret formulas, which the manufacturers protected vigilantly. During the past two years reports on the subject of paint have been presented before the American Society for Testing Materials, the American Railway Bridge & Building Association, and the Maintenance of Way Master Painters' Association, and the report of the committee on Iron & Steel Structures of the American Railway Engineering Association, presented yesterday, also contains an elaborate and valuable discussion of this subject. Thus the railways are themselves securing a greater knowledge of paints and paint materials, and they are therefore able to discriminate more carefully between the various brands on the market. In fact, one or two roads have prepared detailed specifications for the paints they desire to use, and call for bids from the various manufacturers on the basis of the specifications outlined. Equal attention is also being given to methods of application of the paint. Instead of allowing any mechanic to be employed in a painting gang, there is coming to be a greater realization of the fact that this is a trade in itself and that the best results can only be secured by employing skilled workmen.

The Fiscal Year

At various times during the past year we have called attention in these columns to the serious effect of the present limits of the fiscal year on the track department. President Storey emphasized the importance of the same idea in his annual address. The Track Committee yesterday repeated its recommendation of a year ago that the American Railway Engineering Association, strongly urge upon the American Railway Association the adoption of December 31 as the end of the fiscal year, and the president stated that the Board of Direction was now giving this subject its attention. No other single action would have as great a beneficial effect on maintenance of way work. The railways have the means within their own power to make this change, for the only other party concerned, the Interstate Commerce Commission, would undoubtedly offer no objection to changing from June 30 to December 31. The beneficial results which would be obtained by this change are so obvious to every maintenance of way officer that he has difficulty in understanding why the railway executives do not make it. He should not, however, become discouraged with the lack of support, because many important reforms are secured only by prolonged agitation. That progress is being made is shown by the fact that the Erie has decided within the past month to change from the fiscal year ending June 30 to the calendar year in making its annual report to its stockholders. If a few more roads follow this example, the movement may become general. That the calendar year is not unpractical is proven by the fact that two of the largest railway systems in the country, the Pennsylvania and the New York Central, have operated for many years on the calendar rather than the fiscal year.

ENLARGING THE CLEARANCE DIAGRAM

No subject brought out a more vigorous discussion yesterday than that with reference to the clearance diagram proposed by the committee on Iron and Steel Structures. The diagram previously approved and now published in the Manual provides for a minimum horizontal clearance of 14 feet. The diagram presented by the committee increases this to 15 feet. The purpose of the committee in increasing the horizontal clearance was essentially one of safety. The employes' organizations and numerous state commissions have been demanding increased clearances frequently in recent years. As a result a number of states now require clearances considerably greater than those specified by the standards of the association. In opposing the change, Mr. Schall pointed out the effect it would have on the eastern roads built in the more congested centers where any changes are correspondingly expensive. The adoption of an enlarged clearance diagram permitting the operation of larger cars by one road soon affects every other road in the country, for with the present free interchange of equipment the cars of one road may be expected to move over any other line. Representatives of several western roads joined in the opposition to this measure, but on different grounds. Attention was called by several members to the fact that the adoption of increased clearances would soon result in the design of larger cars and locomotives by the mechanical department. Conditions would then soon again be as they now are. In reply to this the chairman of the committee called attention to the fact that any measure which will increase the ultimate returns to the railways are justified. If an increase of the clearances with the resultant revision or rebuilding of the structures will permit the operation of larger equipment and thereby reduce the cost of transportation sufficiently to increase the ultimate net revenue, such changes are justified. The rejection of the proposed diagram by a majority of only five votes indicates the closeness of the decision.

MR. GLEED ON THE HUMAN MIND

Charles S. Gleed is not a politician or in any sense a candidate for the favor of the public. He is a business man, a lawyer, a scholar, a philosopher and a lover of his fellow men. These facts explain the address entitled "About the Human Mind," which he delivered at the dinner of the American Railway Engineering Association last night. He had the courage to make the speech because he is not a candidate for public favor and apparently never intends to be one. He had the knowledge of human nature which enabled him to prepare it because he is a business man, a lawyer, a scholar and a philosopher. And he got up out of a sick-bed to prepare it and came to Chicago to deliver it because he felt that it is the duty of one who loves his fellow-men to take advantage occasionally of good opportunities to tell them a few plain truths about themselves.

Mr. Gleed's address, which is published elsewhere in this issue, is a severe arraignment of human nature, especially of human nature in masses. Dean Swift himself was not more caustic or pessimistic; and one who considered both the substance and the literary attractions of Mr. Gleed's remarks, might regard him as a real, modern Swift. But that would be to fly wide of the mark. For while Swift both castigated and hated human nature, and was hated and deserved to be hated, by most of those who knew him, Mr. Gleed, as we have intimated, is a lover of his kind, and is also one of the gentlest, kindest and most generous of men.

Why, then, does he thus whip mankind with scorpions? Probably he has recently been brooding over the awful catastrophe which has lately befallen Europe and over the recent course of politics and business in his own country. He has for years taken an intense interest in the public regulation of railways and other business concerns; and any intelligent and honest man who is familiar with the kind of legislation regarding business matters which the public during the last ten years has permitted, approved and even demanded, finds it difficult to repose or express much confidence in either the

fundamental intelligence or the fundamental honesty of human nature in the mass.

But there is another side. Somehow, in spite of the imperfections of the human mind and of human character, we do manage to muddle along. We seem to go backward as often as forward, but the cumulative effects of the advances are greater than the cumulative effects of the retreats. The public soon tires of real statesmen and turns them out, but it also soon tires of the demagogues and turns them out, and they are less likely to be called back than the statesmen. When times are good the public, like Jerushun, waxes fat and kicks, the result being foolish attacks on business enterprise; but publicity, discussion and the pinch of hard times soon bring the public around to another point of view. It is seldom possible to appeal successfully to the mere intellect of the public on important questions; but most important questions have to be determined on moral as well as logical considerations, and at bottom the public is honest, and therefore in the long run usually decides important questions right. Of course, as Mr. Gleed indicates, sometimes it is a terribly long run.

Mr. Gleed's speech was fine as far as it went. But we don't think he finished it. He was most eloquent in his pessimism. But we think he could say some more things on his subject, which would be as eloquently optimistic. We have no brief for the human mind. We think that any lawyer who took its case would have difficulty in getting it acquitted, if Mr. Gleed appeared, as he did last night, as attorney for the prosecution. But nevertheless, we think that a pretty good case could be made out for poor, old, befuddled human nature.

TO-DAY'S PROGRAM

The convention will be called to order at 9:30 this morning. The following reports will be presented:

XVII. Wood Preservation.
Special. Stresses in Railroad Track.
VIII. Masonry.
VII. Wooden Bridges and Trestles.
Special. Grading of Lumber.
XVIII. Electricity.
XIV. Yards and Terminals.
II. Ballast.
New Business.
Installation of Officers.
Adjournment.

N. & W. ELECTRIC LOCOMOTIVES

In his discussion of the electrification which the Norfolk & Western has recently completed west of Bluefield, W. Va., C. S. Churchill, assistant to the president, stated before the Western Society of Engineers on Tuesday night that they had been able to replace 33 steam locomotives by 11 electric engines. These figures were inadvertently transposed in our report of this discussion in yesterday morning's Daily. The context explains the ability of the electric power to perform this increased service through the elimination of many of the delays incident to steam locomotive operation.

NEW A. R. E. A. OFFICERS

The result of the election of officers of the American Railway Engineering Association for the coming years, as reported for the tellers by the secretary just before the close of the afternoon session yesterday was as follows:

President, Robert Trimble, chief engineer maintenance of way, Northwest System, Pennsylvania Lines West, Pittsburgh, Pa.; first vice-president, A. S. Baldwin, chief engineer, Illinois Central, Chicago; second vice-president, John G. Sullivan, chief engineer, Western Lines, Canadian Pacific, Winnipeg; treasurer, George H. Bremner, assistant district engineer, division of valuation, Interstate Commerce Commission, Chicago; secretary, E. H. Fritch, Chicago; directors for three years, H. R. Safford, chief engineer, Grand Trunk, Montreal, Que.; C. F. W. Felt, chief engineer, Santa Fe System, Chicago, and A. N. Talbot, professor, municipal and sanitary engineering, University of Illinois, Urbana, Ill.; members of the nominating committee: Paul Didier, principal assistant engineer, Baltimore & Ohio, Pittsburgh, Pa.; Hadley Baldwin, assistant chief engineer, Cleveland, Cincinnati, Chicago & St. Louis, Cincinnati, O.; C. E. Smith, assistant chief engineer, Missouri Pacific, St. Louis, Mo.; F. E. Turneaure, dean, college of engineering, University of Wisconsin, Madison, Wis., and D. J. Brumley, valuation engineer, Illinois Central, Chicago.

PENNSYLVANIA ALUMNI HERE

A number of the alumni of the University of Pennsylvania in attendance at the convention and exhibit took lunch together yesterday at the Hotel Stratford.

LOST—RAILROAD PASSES

C. C. Hill, engineer of construction, Michigan Central, reports the loss of a sole leather case containing his Michigan Central and foreign road passes in the Coliseum on Tuesday. Finder please return to room 1162, Congress Hotel.

B. & B. ASSOCIATION COMMITTEE MEETINGS

The Executive Committee of the American Railway Bridge and Building Association held a meeting at 4 o'clock yesterday afternoon in the Congress hotel. The committee on reinforced concrete bridge work also held an informal meeting for the discussion of its work.

STRESSES IN TRACK

A meeting of the joint committee on Stresses in Track of the American Railway Engineering Association and the American Society of Civil Engineers was held in the Florentine room after the afternoon session Tuesday, at which methods of procedure were discussed and an instrument with which certain preliminary tests have been made was examined.

ROADMASTERS' AND MAINTENANCE OF WAY ASSOCIATION

The chairman and many of the members of the standing committees of the Roadmasters' and Maintenance of Way Association met at the Auditorium Hotel yesterday morning. The committee subjects and committee work for 1915 were discussed and suggestions given. The meeting was for the purpose of reviewing the work already done on the reports for the annual convention. A meeting of the executive officers was also held. The attendance was 25.

VISITORS AT THE COLISEUM

H. E. Speaks, general superintendent of the New York Central at Columbus, was an interested spectator at the exhibit yesterday.

Henry Baker, general manager of the Queen & Crescent Route, attended the exhibit yesterday and evinced considerable interest in automatic train control, cab signals, and automatic stops.

C. C. Hubbell, purchasing agent of the Delaware, Lackawanna & Western, visited the Coliseum yesterday and spent a good deal of time in the signal exhibits. Among the purchasing officers who attended the exhibit yesterday are J. F. Marshall, manager of purchases and supplies of the Chicago & Alton, and F. D. Reed, assistant to vice-president and purchasing agent of the Chicago, Rock Island & Pacific.

Proceedings of Railway Engineering Association

Abstract of Eight Reports, Including Iron and Steel Structures, Rail, Roadway, Ties, Building and Track

The Wednesday morning session of the American Railway Engineering Association was called to order at 9:30 a. m. by President Storey in the Florentine Room of the Congress Hotel, Chicago.

ROADWAY

The Board of Direction assigned the following subjects for consideration:

(1) Continue the study of unit pressures allowable on roadbed of different materials, conferring with committee on Ballast and with special committee on Stresses in Railroad Track.

ROBERT TRIMBLE, President-Elect.

J. G. SULLIVAN, Second Vice-President-Elect.

(2) Submit specifications for the protection of slopes by sodding or otherwise.

(3) Recommend means for the prevention or cure, as the case may be, of water pockets in roadbed.

(4) A petition signed by ten members of the Association, addressed to the Board of Direction, requesting the appointment of a special committee to investigate and report on the subject of separating the grades of roads and streets with railroads, was referred to this committee for such further investigation as might be deemed necessary or desirable.

REVISION OF MANUAL.

A number of changes in the Manual were suggested, most of which were in wording only and did not affect the meaning to any great degree.

UNIT PRESSURES ALLOWABLE ON ROADBED OF DIFFERENT MATERIALS.

The chairman of the sub-committee, J. R. W. Ambrose, has designed and tried out an apparatus for measuring under traffic the pressure at any point exerted by the ballast on the roadbed, which, when calibrated, gives promise of furnishing valuable information. No actual results in pounds per square foot have as yet been obtained.

An air-tight box is placed under the track in any desired position, the upper side of the box having a movable diaphragm. The spring within the box is to keep the diaphragm in the extended position after the load is removed. This box is connected by a pipe or hose to a similar box placed on edge, and having a thin rubber diaphragm; to the center of this diaphragm a connection is made to the side of a small mirror; thus any deflection of the diaphragm is multiplied by the mirror. A ray of light is passed on to the mirror, which in turn is deflected according to the magnitude of the impulse given this transmitter, onto a sensitized film moving at a constant speed, recording the movements of the light ray. In these experiments the transmitter was 12 in. under the tie, covered with gravel ballast; the recording mechanism was located 300 ft. from the track.

During the past year we have endeavored to make a preliminary classification of soils preparatory to investigating the allowable unit pressures thereon. This question has been handled quite exhaustively by the United States Department of Agriculture, and in Bulletin No. 84, Messrs. Fletcher & Bryan describe the apparatus and method of making a mechanical analysis of soils and give seven subdivisions into which soils, excluding gravel, stone and rock, may be divided, namely:

	Material.	Size.	
No. 1	Fine gravel	2. — 1.	mm.
No. 2	Coarse sand	1. — 0.5	mm.

No. 3	Medium sand	0.5	— 0.25	mm.
No. 4	Fine sand	0.25	— 0.10	mm.
No. 5	Very fine sand	0.10	— 0.05	mm.
No. 6	Silt	0.05	— 0.005	mm.
No. 7	Clay	0.005	— 0.0000	mm.

The committee feels that since the first five of the above materials may be determined by screening, that we should define and adopt the following screens as standards:

	Material.	Screens—Pass Through	Retained On
No. 1	Fine gravel	No. 10	No. 18
No. 2	Coarse sand	No. 18	No. 32
No. 3	Medium sand	No. 32	No. 70
No. 4	Fine sand	No. 70	No. 160
No. 5	Very fine sand	No. 160	No. 230

By the number of sieve is meant the number of meshes per linear inch in the wire cloth, woven from brass wire, having the following diameters for

Sieves Nos. 10 and	18	0.0165 inches diameter
Sieve No.	32	0.0112 inches diameter
Sieve No.	70	0.0045 inches diameter
Sieves Nos. 160 and	230	0.0024 inches diameter

The mesh should be regular in spacing and the cloth should be mounted on the frame without twisting. The last two subdivisions, silt and clay, are more difficult to determine, but the method is fully set forth in the Bulletin, No. 84, of the Bureau of Soils, Agricultural Department, above referred to. If the above subdivisions are adopted, we can then classify various soils by giving the percentage of the materials contained. The percentage of water contained in each sample of soil should also be determined by weighing, drying and reweighing, as the moisture content has a decided influence on the bearing power of many soils.

W. M. DAWLEY,
Chairman Committee on Roadway.

SPECIFICATIONS FOR PROTECTION OF SLOPES BY SODDING OR OTHERWISE.

A general letter was sent to all roads, and 124 replies were received. Sixty-eight had nothing to offer, while 83 practiced sodding to a limited extent and 15 to a much larger extent. Out of the 124 replies, only 6 specifications for sodding and 1 for seeding were received.

Seeding does not appear to be in much favor, as only 4 advocated seeding. Protection by tiling or otherwise met with light response; a few favored tiling. Several advocated cinders, while others advocated honeysuckle or willows on wet slopes. Perhaps the reason for the light response was that the Roadway committee made a report on draining banks, with recommendations covering the ground for drainage in quite a thorough manner. Roads in arid countries point out the fact that sodding is useless on account of lack of water, while others in wet countries state that sodding is unnecessary, as the slope soon becomes sodded naturally. The principal points to be covered by the specifications for sodding are as follows:

Nearly all agree that there should be some preparation of the slope, and there should be a dressing of good soil on top. There is a difference of opinion as to manure dressing, the objection being that it introduces objectionable weeds. There is a wide difference of opinion on the limit of slopes that can be successfully sodded, but it is evident that steep slopes can be sodded by pinning the sod until it is well rooted. The difference of opinion on the cutting of sod is largely on account of the different kinds of sod used. For Bermuda and all running plants, it is evident that the sod should be set out in small pieces, so as to grow a new sod. For grasses that do not have creeping stems, this, of course, would not be true, and in that case all the slope should be sodded.

The letters do not show what kinds of grasses require full sodding. All agree that the sod should be well watered until firmly rooted. Most of the replies advocated staking the sod, but this does not appear to be necessary on slopes that are not steeper than 2 to 1.

There is a great difference of opinion regarding settling banks before sodding, but for Bermuda grasses with creeping stems there appears to be no necessity for waiting for banks to settle. For other grasses this is an open question. The correspondence does not show much interest in seeding. We have only one specification for seeding, which appears to be quite complete. On banks that are wet and springy at the toe of the slope, such as steep hillsides or reservoir banks, the planting of willows or other trees should be looked into more fully.

If, in the opinion of the Engineer, pins longer than 8 in., but not exceeding 12 in., or more than two pins per square yard are required, they shall be furnished by the contractor and used without extra compensation.

Sod shall be paid for as measured in place.

Any defects that may appear in the sod or in the work for a period of six months after the work is completed, shall be made good by the contractor at his own expense, and if not attended to promptly after notice from the Engineer, the defects will be remedied by the company and the cost of doing the work will be deducted from payments due the contractor.

The following specifications for sodding with Bermuda Grass are recommended for adoption and inclusion in the Manual:

The slopes should be graded to a uniform surface and all depressions should be filled in with suitable material and padded down firmly with shovel.

Sodding Banks at Toronto.

If the material of the slope is not fertile it should be given a dressing of 6 in. of good rich loam. If good loam is not available a dressing of manure should be placed on the surface and well raked in. Care, however, should be taken against the use of such manure as have seeds of objectionable grasses or weeds. Before placing the loam the surface of the slope should be loosened up roughly to insure a good bond. Lay out the surface of the slope to be sodded in shallow horizontal trenches 12 in. apart and 3 in. deep. Separate the Bermuda sod into tufts or small pieces not more than 4 in. square and apply in trenches at intervals of 6 in. to 1 ft. apart, according to the quality of the sod and the character of the soil, the object being to place only sufficient old sod to furnish enough creeping stems to cover the slope in a reasonably short time, thus creating a new sod on the slope in pref-

erence to the old sod. The top of the sod should not extend above the surface of the slope, and if the season is advanced so that it is liable to have hot or freezing weather the sod should be depressed just below the surface and a covering of loam placed over the soil. Loose earth should also be packed firmly around the sod.

All sod laid during the day should be thoroughly watered as soon as practicable after laying, and no sod shall be left over night not laid without water. All sod shall be watered daily for 20 days after laying. On slopes steeper than 2 to 1 the sod shall be in narrow strips 3 to 4 in. wide and 3 ft. long, and shall be staked to the bank with small stakes 8 in. to a foot long, stakes being placed every 1½ ft. apart. After the slope has been filled, sod should be rolled or firmly padded down with a shovel to a smooth uniform surface. All sod must be taken from good, rich soil, be uniform in texture, free from objectionable grasses or weeds and in healthy condition, with no signs of decay, and must contain sufficient moisture to maintain its vitality during transportation.

Sod should preferably be cut 3 ft. or more long and 18 in. to 2 ft. wide and not less than 2½ in. thick, large pieces of sod being preferable on account of retaining their moisture and standing transportation better than small pieces. Sod should be as fresh as possible and received on the work daily. Any sod to be left over night should be thoroughly watered. Any sod that is heated will not be accepted. All sodding must be finished before the continued frost sets in.

Sod shall be paid for as measured in place, and shall include the entire surface sodded—this price to include the furnishing the sod and handling it. Transportation of sod, men and material, also to include stakes where it is necessary to take the sod. The entire work shall be done in a thoroughly workmanlike manner so that the appearance after completion shall be as nearly as possible that of good natural growth in place.

All objectionable grasses and weeds shall be removed from time to time to prevent shading the grasses until such time that the sod has taken hold or the creeping stems have covered the entire slope. Where springs have developed on the slope a blind drain of cinders or broken stone should be laid from the spring to the top of the stone should be laid from the spring to the toe of the slope.

MEANS FOR THE PREVENTION OR CURE OF WATER POCKETS IN A ROADBED.

A circular letter, containing a list of 8 questions on this subject, was addressed to those members of the Association directly in charge of maintenance work, or who were supposed to have a detailed knowledge of the treatment of water pockets. Fifty-three replies to this letter were received.

From a consideration of the data now in hand, it is concluded that our knowledge of water pockets in the roadbed is yet in its experimental stage, and it is so related to other questions now being investigated by the Association that it would be inadvisable at this time to attempt any recommendations on the subject.

In reporting progress it is the purpose of the sub-committee to give a resume of its investigation to date, in order that individual members of the Association may further continue the investigation during the forthcoming year and be prepared to assist the committee in reaching its conclusions.

Briefly, a water pocket may be defined as "a depression in a roadbed of variable extent, with ballast or other porous material, wherein water collects and is confined." From opinions expressed, it appears to be well established that the underlying causes of water pockets are the absence of adequate drainage in roadbed; the deformation of the original roadbed prior to ballasting; and an insufficient depth of ballast and heavy wheel loads and the action of frost on the roadbed in climate where the frost line extends below sub-grade. It is also the opinion there is an increased tendency towards the formation of water pockets on old operated lines, which might naturally be expected to follow a neglected track drainage and improper ballast requirements for the increased wheel loads on such lines. The committee's assignment requires two lines of investigation: The prevention of water pockets and the cure of water pockets. It is our conclusion that the prevention of water pockets is the more important subject to be dealt with, and since our investigation will naturally lead to a consideration of the proper depth of ballast and unit allowable pressures on roadbed surface, we must await the conclusion of other committees now handling these subjects.

Prevention of Water Pockets.

Many descriptions of methods tried by various members to prevent water pockets in newly constructed or ballasted track have been reported, but there appears to bo no uniform practice. One reply to our circular advises that extreme care should be exercised prior to ballasting to remove all deformation and to properly shape the roadbed surface so as to quickly shed all water. In this connection it is stated that more water pockets are formed in one day by permitting engines and cars in rainy seasons to use track laid on a flat sub-grade without full ballast, or with no ballast at all than would be formed in years with a sufficient depth of ballast, as in every case where tie beds itself into the roadbed surface a deformation occurs, which collects and holds water and gives foundation for a water pocket, regardless of the amount of ballast afterwards applied.

One of the two lines reported that it is their practice in opening up new track to traffic to spread over the entire roadbed, prior to ballasting, a layer of sand, sandy loam, granulated furnace slag, screenings from stone crushers of certain impervious materials which have been found will shed water. When this material has compacted, ballast is applied, and no trouble is experienced from water pockets.

Bridge-filling methods on some operated lines have been found to be responsible for water pockets in embankments. We are informed by one member, who has made a special study of bridge-filling methods, that where a new fill is permitted to settle before the deck and stringers are removed, water pockets invariably appear, and the amount of trouble experienced in the upkeep of the track varies in proportion to the length of time the stringers and deck remain. He advises that in the past eight years he has made it a practice to remove the deck and stringers when banks are not filled to over 10 or 12 ft. wide on top, and in 12 linear miles of bridges filled, water-pocket trouble was absolutely eliminated.

In climates where the frost line extends below the sub-grade, when the frost is leaving the ground, thawing from the top downward, that part of the soil which has thawed, retaining all its moisture, on account of the impervious frozen layer of soil beneath it, becomes almost liquid, thus losing its supporting power, and it is readily displaced from beneath the ties under traffic. On account of slight variations in the character of the soil, this displacement is not uniform, and the resulting inequalities leave depressions in which water accumulates. The methods suggested for the prevention of water pockets formed in this manner are to carry the ballast below the frost-line, adopt some method of raising the frost-line (soil in extreme cold weather freezes but a few inches deep under a good sod), or to construct the upper portion of the roadbed of frost-resisting materials.

We are indebted to H. T. Porter, chief engineer, and F. R. Layng, engineer of track of the Bessemer & Lake Erie, for the following description of an unusual method of preventing water pockets in new track:

"Between Keepville and Albion, 2.4 miles, the Bessemer & Lake Erie was a single-track road on the towpath of the Erie and Pennsylvania canal, the towpath being approximately 8 ft. above the canal bed. In 1910 it was decided to double track this line and the material was excavated by steam shovel at Albion, hauled on flat cars, plowed off with a side plow and spread with a Jordan spreader. The material consisted of shale and clay of such character that it was unfavorable to good drainage. With the idea of consolidating this material and forming a crust at sub-grade so that the ballast would not punch holes into the sub-grade, a 10-ton Kelly-Springfield roller was used to roll the sub-grade behind the spreader. If the roller developed soft spots they were replowed and rolled again, with the result that before track was laid we had a hard crust formed at the top of the grade. The rolling for the 2.4 miles cost $300, or at the rate of $125 per mile. The track was then laid and ballasted with screened slag and has not been given a resurfacing since. On this entire stretch there is not a single indication of the formation of a water pocket. This new track is the northbound main, and during nine months of the year carries from 24 to 30 freight and three regular passenger trains daily. As a matter of fact it has hardly been necessary to set a jack under this track, and no lining has been done except in a few spots. It is remarkable the way the track has stood up, and it is our belief that the rolling of the sub-grade is in a large measure responsible for the results obtained."

No methods of preventing water pockets in old-operated track have as yet been reported, evidently for the reason it has not yet been possible to tell where and when a

pocket may develop. Every one admits that adequate drainage of the ballast and roadbed surface is essential to prevention, but it does not seem that anything but the usual maintenance methods are followed prior to formation.

In conclusion, the Committee asks the members of the Association to further study the prevention of water pockets along the following lines: (1) In new track, single and multiple. (2) In old-operated tracks, single and multiple. (3) Filled bridges and (4) yards and terminals.

Cure of Water Pockets.

Water pockets have been known to some of our members for 20 years or more, and it is quite natural that methods of cure should be generally known, but, nevertheless, there appears to be a wide difference of opinion as to the most practicable and economical methods. In cuts it is the prevailing opinion that tile drains give the most satisfactory relief from water pockets, but the kind of tile and in what relation to the end of the tie it should be laid is a problem yet unsolved. It appears to the committee that only vitrified socket pipe of a diameter not less than 6 in. should be used for draining cuts, but we are not yet prepared to recommend any specifications for laying or its position in relation to the track.

In embankments, water pockets are prevalent at the ends of the cuts at low points in grade, at trestles replaced by embankments along multiple tracks, and many other points where drainage has become impaired. Relief in such places is secured by opening the pockets and restoring drainage. The methods of restoring drainage to pockets in embankments are many, but the one most widely used consists of cross-draining or tapping the pockets with trenches back-filled with porous material. In many cases drain tile is laid in the trenches, but it is not always beneficial, on account of the tendency to shift its lines and grade under pressure of the load from above or the distortion of the walls of the trench.

The life and efficiency of cross-drainage depends largely upon the depth of the trench and the character of the material used in back filling. Where a proper outlet can be obtained, present experience would seem to indicate that the bottom of the trench should be placed at least 12 in. below the lowest point of the pocket to be drained. Material for back filling consists of cinders, furnace slag, gravel, crushed stone or riprap. It, however, does not appear to the committee that any of these materials alone, with the possible exception of furnace slag, will make an efficient and permanent drain, but that any of the materials mentioned in combination with cinders will give better results. This statement is based upon experience with drains composed of crushed stone or gravel, where in the course of one or two years' life they have been found completely filled by the material from the walls of the trench forcing its way into the voids.

Somewhat similar experience has been had with cinder-filled trenches, except that, instead of the voids being filled, the walls of the trench have become distorted under pressure from loads on track, and have so compressed the cinders as to render them useless for purpose of drainage. It appears that an ideal material for back-filling is one that will prevent the distortion of the walls of the trench and at the same time permit water to filter through. It is believed that a mixture of stone and cinders or slag and cinders will best fulfill these conditions, but a definite conclusion will depend upon further investigation.

Other methods of curing pockets which have been reported consist of driving old boiler tubes into pockets from the side of the embankment, the plowing away of the shoulder to a considerable depth below the base of the tie and restoring the slope with sand, ballast and other pervious material, widening banks and increasing depth of ballast, etc.

Interesting information regarding the difficulties experienced in curing a section of track of water pockets is found in the following quotation from a letter from a member of the Association:

"A section of high-speed main track 4,000 ft. long required constant attention on account of water pockets. We started to overcome this condition by cleaning out the water pockets and running out short sub-ditches from them each year for several years. This became a perpetual nuisance, however, and we made little if any, improvement in track conditions. A little later on we dug the sub-ditches reasonably deep and cleaned out the ballast in quite a thorough manner to permit of the free flow of water from the roadbed through the ballast in the sub-ditches. This afforded excellent relief for the first year, a reasonable degree of relief during the second year, and fair relief during the third year. We observed, however, that we were gradually getting back into the same condition that we were in originally. We then laid a line of pipe between each of the four tracks, and also a larger line of pipe in the outside ditch, with cross drains leading from the lines of pipe between the tracks to the main side pipe. These pipes were laid with the flow line about 34 in. below the top of the rail, because of local conditions, and we filled over them with ashes to the top of the sub-grade. We then cleaned the ballast thoroughly to sub-grade, making what was practically a newly constructed piece of track with ample provision made for drainage. This piece of track was renewed about two years ago.

"Since this improvement was made very little attention is given to this section of track. Both rail and tie conditions have been improved. In former years, when we had a severe storm, the tracks were submerged and water ran from them for several days afterwards. Now, in a few hours after a storm has abated, the pipes are practically dry. During the course of a storm no water is seen on the roadbed, but a large volume is discharged from the mouth of the main pipe, being fed by the smaller pipes between the tracks. We have established manholes just below the ballast surface every 500 to 600 ft. to provide for cleaning out, if necessary, although no such attention has been required. We feel that we have been amply repaid many times over for the expense that we have gone to in connection with this particular piece of track."

CONCLUSIONS.

(1) That the classification of soils be adopted and included in the Manual.

(2) That the specifications for sodding with Bermuda grass be adopted and included in the Manual.

W. M. Dawley (Erie), chairman; J. A. Spielmann (B. & O.), vice-chairman; J. R. W. Ambrose (G. T.), A. F. Blaess (I. C.), Ward Crosby (C. C. & O.), W. C. Curd (M. P.), Paul Didier (B. & O.), R. C. Falconer (Erie), S. B. Fisher (M. K. & T.), Frank Merritt (G. C. & S. F.), L. G. Morphy (B. & A.), F. M. Patterson (Interstate Commerce Commission), W. D. Pence (Interstate Commerce Commission), L. M. Perkins (H. P.), W. H. Petersen (C. R. I. & P.), A. C. Prime (P. R. R.), H. J. Slifer (Cons. Engr.), J. E. Willoughby (A. C. L.), W. P. Wiltsee (H. & W.), Committee.

Discussion on Roadway.

Chairman Dawley presented the report.

Chairman Dawley: The subject of Unit Pressures Allowable on Roadbed on Different Materials should have further consideration. The committee has drawn no conclusions, and would ask the Association to follow up the subject along the lines of, first, prevention and cure of water pockets in new track, single and double; second, in old operating tracks, single and multiple; third, in field bridges, and, fourth, in yards and terminals, giving the committee the benefit of their experience during the coming season.

John G. Sullivan (C. P. R.): There is one point in paragraph 23, under the specifications for the formation of the roadway, that has caused some trouble, and that is the latter part. It says: "The classification of the material shall be in accordance with its conditions at the time of removal, regardless of prior conditions." In overbreak in rock cuts, if you classify that as loose rock, most specifications do not specify how it shall be measured. We know that loose rock will measure more than the space it occupies as solid rock in the cut. In order to avoid disputes I have inserted in our contracts that the measurement shall be the original space occupied by the material regardless of classification. That may be wrong or may not be, but it is definite and a man knows when he is taking a contract how he is going to be paid. I will move that there be added to that paragraph that the measurement of this material shall be the original space occupied, regardless of the classification.

J. E. Willoughby (A. C. L.): The objection to classifying it when it is softer than it was in its original position is that it is not quite fair. It is entirely feasible to cross-section a slide, after it has come into a cut.

Mr. Sullivan: I have no objection to making it that way, but make it something definite.

W. H. Courtenay (L. & N.): One objection to Mr. Sullivan's suggestion is that certain slides cannot be met. They frequently extend four or five hundred feet in the roadbed, and come down gradually, and as you take them out they develop. The ground crumbles up gradually, slides down a little at a time. In many cases they occur where it is impracticable to measure the space occupied by the slide. It is a difficult question any way you look at it.

A. W. Carpenter (N. Y. C.): I would offer as an amend-

ment to insert in the last sentence of the paragraph, after the word "classification," the words "and measurement."

Mr. Sullivan: I can see that we are going to have the same trouble here that we are having with all the specifications. You have your measurements on the building of the line, and the material comes down, broken down probably, or a slide. You must recognize that we can't build a railroad without having an overbreak, or else use a channel and cut out in a straight line. Where you divide the classification between solid and loose rock, or give it all loose rock, how are you going to measure it? It all goes out at the same time. You can't possibly measure during construction. I have had no trouble in doing work with the specifications I have mentioned, and I have had trouble when I did not have that clause in. The only possible way in construction work, when you are taking out rock cut, to measure overbreak, is the solid contents of the cut.

J. R. W. Ambrose (Toronto Term.): I will second Mr. Sullivan's motion. The work that has been done on the Grand Trunk within the last year or two has not had a great deal of solid rock. But they have had some work in the West where there is a great deal of solid rock taken out and considerable overbreak, resulting from, perhaps, carelessness. The question of measurement, it seems to me, is independent of the classification.

J. L. Campbell (E. P. & S. W.): I agree with the impracticability of determining the volume of this broken material other than by proper cross-section after the excavation has been completed. Moreover, I believe the space originally occupied is the fair basis for determining what shall be paid for the work on the classification, and I believe in the case of rock the proper classification would be loose rock.

(The President put to vote the amendment offered by Mr. Sullivan, and it was adopted.)

In 48-a, the second sentence in the fourth paragraph was changed to read, "The compensation to be rendered therefor shall be determined by multiplying the *excavation* yardage, etc."

Mr. Campbell: I would offer this as a substitute for paragraph 59: "The contractor shall, without loss or liability to the company, construct all roads necessary for his use in the execution of this contract."

Chairman Dawley: The committee is willing to accept that amendment.

Mr. Sullivan: In paragraph 60, "where designated" is quite broad. Would not the committee be willing to put some limit to that distance? I would say that we change that wording to read, "Where designated, within limits agreed upon."

Chairman Dawley: The committee will accept that.

Mr. Campbell: In paragraph 5, under "General Contract Requirements," I believe this part of the contract requirement should be referred back to the committee for consideration of the specified width of the roadbed. I do not believe the width stated Class A, 20 ft.; Class B, 16 ft., and Class C, 14 ft., are wide enough. I do not think they are as wide as the roads are now finding it necessary to build. I notice that the Committee on Ballast has recommended a width of 26 feet for ballasting tracks.

The President: It seems to me to be advisable to refer this paragraph back to the committeee.

Hunter McDonald: I do not know whether the committee has been in touch with the committee which has been appointed by the American Society of Civil Engineers on the question of soils. I understand that committee is making a very extended, thorough and scientific research into this question. I think the adoption of this matter at the present time would be premature and I should oppose it being done.

A. M. Talbot (U. of Ill.): I would like to bring up a question concerning the terms used in the list under unit pressures allowable on roadbed of different materials. I understand these refer to the sizes and the grades of these different classifications. We have to look out in regard to bearing upon other lines of work, as, for example, mortar and sand, where the largest grains are the grains which would be compared with the terms used here. By the classification of sand for mortar purposes adopted by the Association, the size of sand may run up to one-quarter of an inch particles, passing an opening one-quarter of an inch in diameter. The term "high in gravel" used here is for the largest size. The term coarse sand; while this is given as very fine sand. it is mastandard Ottawa sand used in testing cement; not a very coarse sand; while this is given as very find sand, it is material which we would hardly consider as available for such things as mortar-making purposes. I would like to suggest two things in this: That some word be added after these terms, like size or grain, to distinguish between this mortar classification, that which is used for mortar-making purposes, and instead of the words "fine gravel" the term "very coarse sand" be employed. Personally, I should be pleased to see these sizes made somewhat larger than they are, but I don't think that is an important point.

(Conclusion (1) was referred back to the committee and Conclusion (2) was accepted.)

RECORDS AND ACCOUNTS

The following subjects were assigned:

(1) Make a comprehensive study of the forms in the Manual, adopted a number of years ago, and bring them up to date.

(2) Continue the study of reports required by Federal and State railway commissions.

(3) Continue the study of a feasible and useful subdivision of I. C. C. classification account No. 6, with a view to securing uniformity of labor costs.

The sub-committee appointed to deal with revision of the Manual and the study of the forms in the Manual suggested a few minor changes.

In connection with reports required by State and Federal Commissions, the committee feels that there is a diminution of the activities of the state commissions in connection with the valuation of railway property and a tendency on their part to await the valuation now in progress by the Interstate Commerce Commission.

W. A. CHRISTIAN,
Chairman Committee on Records and Accounts.

SUB-DIVISIONS OF I. C. C. CLASSIFICATION ACCOUNT.

Since this subject was assigned to the committee, the Interstate Commerce Commission has issued a new classification of operating expense accounts, which went into effect on July 1, 1914. In that new classification former account No. 6 has been divided into two parts—No. 202, Roadway maintenance, and No. 220, Track laying and surfacing. The splitting of this account into two parts perhaps reduces the necessity of further sub-dividing the two new accounts. However, in the event that this further sub-division is desired, the following sub-divisions are submitted for consideration of the Association:

Account 202, Roadway Maintenance:
(A) Care of Roadbed;
(B) Bank Protection;
(C) Clearing and Cleaning Roadway and Track;
(D) Watching Roadway and Track;
(E) Flood Damage;
(F) Work Train Service.

Account 220, Track Laying and Surfacing:
(G) Renewing Track Material;
(H) Maintenance of Line and Surface;
(I) Other Expenses;
(J) Work Train Service.

The application of the sub-divisions above mentioned to the various divisions of these two accounts, as shown in the I. C. C. Classification, would be as follows:

No. 202. Roadway Maintenance.

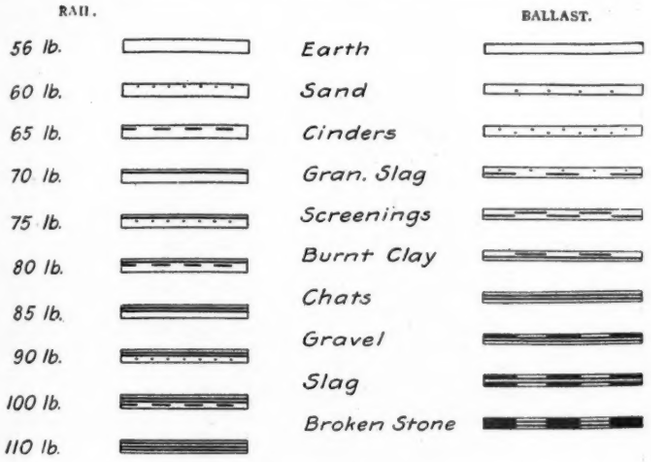
1A. *Care of Roadbed.*—The cost of blasting rocks; constructing and cleaning tile ditches, open ditches and drains;

crowning track ties with retaining earth; filling borrow and cattle pits; landscape gardening along the roadway; oiling the roadbed; removing dangerous rocks; removing slides; restoring roadbed, cuts, fills and embankments to standard width; sloping cuts; sodding roadway; **E,** building temporary tracks around slides and washouts; keeping tracks clear and repairing subgrade in case of washouts; removing temporary tracks around slides and washouts; repairing roadbed damaged by washouts.

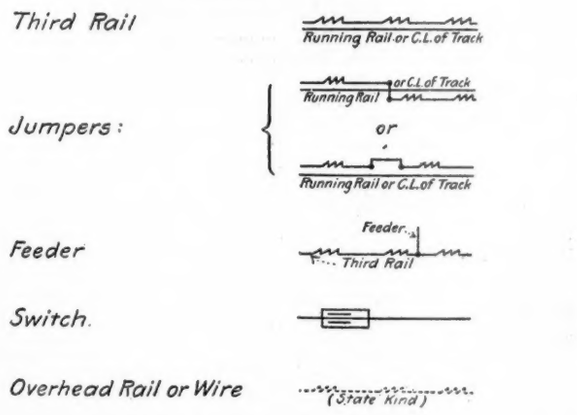
2C. *General Cleaning.*—The cost of cutting, removing and disposing of brush, grass and weeds from the right-of-way; plowing and digging fireguards; dressing ballast and cutting sod lines; removing miscellaneous scrap, drift, cinders, dirt and other material from right-of-way and from road and terminal tracks (including tracks at stations, engine yards and car yards), and cleaning streets used as roadways.

3D. *Watching Roadway.*—The cost of extinguishing fires of the right-of-way and adjacent thereto, and of walking, watching and patrolling tracks and right-of-way.

4B. *Bank Protection.*—Cost of protecting banks by repairing retaining walls, riprap, piling, piers, dikes, breakwaters



ELECTRIFIED LINES.



Proposed Conventional Signs.

and revetments, and by changing the channels of streams to prevent cutting, washing and sliding of embankments.

5F. *Train Service.*—The cost of work-train service in connection with work pertaining to roadway maintenance.

6A. *Track Changes.*—The cost of roadway work in connection with taking up and relocating tracks.

7A. *Other Expenses.*—The cost of roadway work not provided for elsewhere, such as official roadway inspection train service and premiums in connection with roadway maintenance.

No. 220. Track Laying and Surfacing.

1G. *Applying Ballast.*—The cost of labor expended in preparing the roadbed and applying ballast for repairs of tracks.

2G. *Applying Ties.*—The cost of labor expended in unloading, distributing and applying ties for repairs of tracks; in gathering up and disposing of the ties released; **H,** and in respacing ties.

3G. *Applying Rails.*—The cost of labor expended in unloading, distributing, cutting, slotting, drilling, adzing for and laying rails for repairs of tracks; in gathering up and loading rails released; **H,** and in adjusting for expansion and contraction of rails.

4G. *Applying Other Track Material.*—The cost of labor expended in unloading, distributing and applying other track material for repairs of tracks, and the cost of gathering up and loading the material released.

5H. *Track Maintenance.*—The cost of labor expended in alining, surfacing, gaging and shimming tracks; in tightening track bolts and track spikes; in restoring rails, ties and ballast in case of washouts, derailments and wrecks, and taking up tracks.

6J. *Train Service.*—The cost of work-train service (except work trains distributing ballast material) in connection with work pertaining to track laying and surfacing.

7H. *Track Changes.*—The cost of track work (exclusive of the cost of track material) in taking up and relocating tracks.

8I. *Other Expenses.*—The cost of track laying and surfacing work not provided for elsewhere, and expenses, such as repairing and replacing rail rests, official track inspection train service, and premiums in connection with track repairs.

The numbers indicate the I. C. C. classification subdivisions; and the letters indicate sub-divisions under which the whole or portions of the I. C. C. sub-division are classified.

CONVENTIONAL SIGNS.

The committee submits herewith for approval additional symbols relating to "Rail," "Ballast," and "Electrified Lines." These symbols were incorporated provisionally in the pamphlet issued during the summer of 1914, and are now in use by railway companies in the work of preparing maps and profiles to comply with the Government valuation act:

W. A. Christian (I. C. C.), chairman; M. C. Byers (W. M.), vice-chairman; F. J. Bachelder (Cons. Engr.), W. S. Danes (Wabash), Lester Bernstein (B. & O.), G. D. Hill (I. C.), Huntington Smith (N. Y. C. & St. L.), Henry Lehn (N. Y. C.), J. H. Milburn (B. & O.), J. W. Orrock (C. P. R.), J. C. Patterson (Erie), H. C. Phillips (A. T. & S. F.), J. H. Reinholdt (M. & St. L.), R. C. Sattley (C. R. I. & P.), Guy Scott (P. L. W.), H. M. Stout (N. P.), Frank Taylor (C. R. R.), J. L. Vollintine (C. B. & Q.), W. D. Wiggins (P. L. W.).

Discussion on Records and Accounts.

The suggested changes in the Manual were adopted. The suggestions under "Sub-divisions of I. C. C. Classification Account" were received as information. "Conventional Signs" were next considered.

W. H. Courtenay (L. & N.): It is utterly unnecessary to adopt that complicated system of symbols to designate the weight per yard of the rail. It is much cheaper and quicker to adopt the method of marking the weight per yard in figures. It will take draftsmen a long time to represent the weight per rail by these symbols. It will be a considerable strain on the memory of the man who refers to the drawing data to recognize one of these symbols. If he has the figures before him there will be no mental strain whatever. I move that the convention do not adopt the conventional symbols to designate the weight per yard of the rail, but in lieu thereof represent the rail by one straight line, with the weight per yard marked on it in figures The valuation engineers of the Interstate Commerce Commission have indicated their intention to adopt the symbols that are adopted by this Association. If the valuation engineers demand that this system of symbols be used to designate the weight of the rail, it will add to the cost of the preparation of the maps.

Chairman Christian: If you will go back to the Manual you will find that the Association approves colors representing the different weights of rail. We have tried to relieve all carriers of using any colors on account of blue prints, and we put in these symbols as a substitute.

(Mr. Courtenay's motion was put and carried.)

The President: The ballast symbols will be counted as approved, together with the symbols for electrified lines.

TIES

The following subjects were assigned:

(1) Continue the study of the effect of the design of tie-plates and track spikes on the durability of cross-ties. (Not reported on.)

(2) Continue the study of the economy in track labor and material affected through the use of treated compared with untreated cross-ties.

(3) Continue the study of metal, composite and concrete cross-ties, building up a history of same.

(4) Investigate and report on the future timber supply for ties (not reported on).

(5) Report on the distribution and care of cross-ties.

STUDY OF THE ECONOMY IN TRACK LABOR AND MATERIAL EFFECTED THROUGH THE USE OF TREATED COMPARED WITH UNTREATED CROSS-TIES.

The committee reported in last year's proceedings as fully as is possible at present on the comparative cost and life of treated and untreated ties. Various experiments with ties are being made which will in future furnish valuable data on the subject. It is evident that there are wide differences in the manner in which tests of tie life are being made, as well as in the way in which the records of the tests are kept by different railway companies. It is therefore suggested that standards of tie-life tests and of tie records be adopted by this Association, in order that the greatest possible benefit be derived from future experiments along these lines. In 1918 it is estimated that the Association may with profit again take up this subject with a view to tabulating information which will then probably be available.

The committee recommends for adoption and publication in the Manual:

Economic Comparison of Railroad Ties of Different Materials.

Except in isolated cases, ultimate economy in labor and material results from the use of properly treated ties, as compared with untreated ties.

Photo by Moffett, Chicago.

L. A. DOWNS,
Chairman Committee on Ties.

The economy of any tie of known price and life may be determined by the following formulas:

Given:
C = First cost of tie in place;
C¹ = Amount at compound interest which will produce interest equalling the first cost of tie during the life of the tie;
R = Rate of interest;
n = Life of tie in years;
I = Interest on first cost.

Required—Total capitalization of tie:

$$= C + C^1 = \frac{C\,(1+R)^n}{(1+R)^n - I} \quad \ldots\ldots\ldots\ldots\ldots\ldots (1).$$

Given:
C = First cost of tie in place;
R = Rate of interest;
I = Interest on first cost;
A = Amount at compound interest which will provide for renewal at end of life of tie.

Required—Total annual cost:

$$I = CR$$

$$A = \frac{CR}{(1+R)^n - I}$$

Total annual cost =

$$I + A = \frac{CR\,(1+R)^n}{(1+R)^n - 1} \quad \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Given:
R = Rate of interest;
C = Cost of tie of n years life;
C¹ = Cost of tie of n¹ years life.

Tie costs are equivalent when the capitalization or annual costs are equal, or

$$C^1 = \frac{C\,(1+R)^n}{(1+R)^n - 1} \times \frac{(1+R)^{n^1} - 1}{(1+R)^{n^1}} \quad \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

USE OF METAL, COMPOSITE AND CONCRETE TIES.

During the year the sub-committee assigned to report on the use of metal, composite and concrete ties inspected substitute ties on the Bessemer & Lake Erie, the Pennsylvania Railroad, the Pennsylvania Lines (Northwest System), the Pittsburgh & Lake Erie and the Union Railroad of Pittsburgh. They have also taken up with each railroad on which substitute ties have been used the question of a report for this year, and the more important replies received bringing out new information, are given below:

"Fifty cast steel ties manufactured by the Metal Tie Co. were installed in the Baltimore & Ohio eastbound main track in March, 1909. A recent examination showed the ties to be in fair condition. The wooden blocks, however, have to be renewed on account of splitting. This renewal was made about a year ago. Screw spikes and screw spike tie-plates are in use. The track seems to hold to good line and surface, although the expense of maintenance is probably greater than with the ordinary tie, on account of the depth to which it is necessary to go in order to surface."

Since the Bessemer & Lake Erie first started to use the I-beam tie in 1904, 1,012,939 of the M-21 section (8-in. base) have been purchased and at the present time approximately 87 per cent. of the main line between North Bessemer and Conneaut Harbor, a distance of 141 miles, is laid with these ties. Of this 141 miles, 130 miles is double track and 8.9 miles is two single-track lines. These ties continue to give satisfaction, nothing having developed in the ten years they have been in that would indicate that the tie is not a practical substitute for the wood tie.

In 1908 a number of ties were carefully weighed separately, the actual weight was stamped with a steel stamp on each tie and put in the track at various points. In 1914, just six years later, 30 of these ties were taken out and reweighed after being given a thorough cleaning. The following is the result:

Original weight of 30 ties	5,213 lbs.
Present weight of 30 ties	4,912 lbs.
Loss in six years	301 lbs.
Loss per year	50 lbs.
Loss per tie per year	1.6 lbs.

In June, 1914, 3,200 ties of a heavier design were installed in the southbound track one mile south of Hartstown, Pa. They were laid under new 100-lb. A. R. A. type B rail, spaced 20 to a 33-ft. rail, and ballasted with screened slag. The ties are not insulated. This tie is known as Carnegie Steel Company Section M-28 and weighs about 27.75 lb. per ft., making the weight per tie 8 ft. 6 in. long, 235.9 lb. The fastenings weigh 33.4 lb., so that the weight complete is 269.3 lbs.

A comparison of the detail dimensions of this tie and the M-21 tie which is the section of which the road has over a million, is made below:

Section	Depth	Weight per ft.	Area section	Width of Top	Flange Bottom	Web	Weight tie only 8 ft., 6 in. long
M-21	6.5	21.2 lbs.	5.9	4.5 in.	8 in.	7/16 in.	181 lbs.
M-28	6.5	27.75 lbs.	8.18	5 in.	10 in.	5/8 in.	236 lbs.

In 1913 the Elgin, Joliet & Eastern installed 494 sets and in 1914 85 sets of steel switch-ties. In 1913 we used 1,638 steel cross-ties and in 1914 240 steel cross-ties. We have 160 sets of steel switch-ties on hand which will be put in track next year. In every case where we put in steel switch-ties we are putting in new gravel ballast, as we find that the old ballast contains considerable cinders, which, of course, is very hard on steel ties. The 62 Bates concrete ties we have in at Whiting are still in service and are apparently in as good condition as when first placed. They are certainly holding up in good shape.

The Florida East Coast installed 16 Percival concrete ties in the main line at St. Augustine in March, 1906. They are under 70-lb. A. S. C. E. rail and in sand ballast. Twenty-four trains pass over them daily. The 16 ties are under one rail. No defects have developed. Examination shows that they are in good condition in all respects. The fastenings are holding well and have never been touched since they were put on. The cushion between the bottom

of the rail and the tie is made of gumwood and has never been changed. The present shape of the ties between the rails is a "V" and they do not hold up well in our sand, but if the ties were flat-bottomed it is thought that they would.

A number of Percival concrete ties are interspersed with ordinary ties on the Galveston, Harrisburg & San Antonio at Edgewater, Tex. These ties were installed October 22, 1906. A derailment broke three ties, which were replaced by cypress ties, and disfigured 14 other ties. On Jan. 28, 1908, the defaced ties were replaced, but the three removed after the wreck were not replaced, thus reducing the number of ties in the track from 50 to 47. This derailment did not occur on the concrete ties, but on wooden ties, and the derailed car ran onto the concrete ties. Since date of replacement and up to July 1, 1914, ten ties have broken and have been replaced with cypress ties. An inspection during July, 1914, showed that all wooden cushions were badly cracked and must be removed. Seven ties were cracked and broken under rail and six or eight screw spikes were broken off. All failures were under rail and there were no noticeable cracks in the center of the ties.

In another test section at the same place the ties were laid out of face. An inspection in July, 1914, showed all wood cushions badly cracked and six cushions entirely rotten. All are to be renewed. Three ties were broken under the rail. All failures were on joint ties. The one tie reported as having been renewed last year was an error, as none of the original ties were changed.

Another test is being made of Percival concrete ties 7 in. by 8¼ in. by 8 ft. at Bayou Sale, La. There are 96 ties, the joint ties having been inserted after the chart was made. All ties are sound and in good condition with no cracks except in one tie. All wood cushions are cracked with the grain of wood. Owing to the practice of dumping cinders on this track, the majority of the wood cushions are burnt.

A number of National steel ties have been in the track of the Pennsylvania Lines, Northwest System, near Emsworth, Pa., about ten months and all are still in good condition. The cost of maintenance has been about the same as the cost of maintenance for an equal number of wooden ties. The traffic passing over these ties the last year has averaged about 60 passenger and 10 freight trains.

Fifteen Reigler concrete steel ties were placed in the westbound main passenger track of the Pennsylvania Lines just west of Emsworth, Pa., May 9, 1908, where they have been subjected to heavy traffic. All of the ties are still in good condition and giving satisfactory service, with no apparent depreciation. They have now been in the track 6½ years. The action of these ties under traffic shows that there is considerably less deflection of the track than in the adjacent wood tie track. No separate records of the cost of maintenance have been kept, but the opinion of the supervisor is that much less work is required for both line and surface than for wood ties. An average traffic of about 60 passenger and 10 freight trains passes over this track daily.

Twelve Rohm steel ties were installed in the eastbound freight track of the Pennsylvania just east of Chestnut street, Sewickley, Pa., on June 15, 1910, and have now been in the track about four years and four months. Three of these ties have been removed from the track because of the failure of the wedges to keep the clamps tight. They will be put back again as soon as new wedges are received. It is necessary to tighten the wedges about once a month. As these ties are spaced alternately between wooden ties, it is impossible to keep any record of the cost of maintaining surface and line, but it is thought that they require about the same amount of surfacing as wood ties, and a little more work that wood ties to keep in line. The hollow triangles have been filled with cinders and considerable rust has taken place.

DISTRIBUTION AND CARE OF CROSS-TIES.

Untreated Ties.

On many roads it is necessary for the purchasing agent to have in the fall an estimate of the number of ties required the next spring for renewals, but an actual count in the fall comes so close upon the renewals made in the summer, when all unserviceable ties are supposed to have been removed, that it is but little better than a guess. On old roads an estimate based upon the average renewals for a series of years is more rational than an actual count in the fall, and is sufficiently close for the purchasing agent. Just before the time for distributing comes, the ties should be inspected and a record made of the number needed for renewals (1) between each two telegraph poles, or (2) on each curve and on each tangent.

In the first method the number should be marked with chalk on the pole which stands in the direction from which the train will come when distributing; the best plan is to take a short ladder and place the marking out of reach of mischievous persons. In the second method the number for each tangent and for each curve should be recorded in a book and the ties unloaded accordingly. Another method that is sometimes followed is to drive a stake on the shoulder temporarily for each ten ties required. When the ties are unloaded, any one of the three methods will make it an easy matter to throw off the required number, almost in place.

The details of the work of distributing wood ties for renewals vary considerably with different roads, according to conditions of supply, density of regular traffic, ideas concerning economical methods, etc. Where the supply of ties can be bought in the district tributary to the road they are usually received at the stations or at sidetracks or at other points along the right-of-way and loaded upon flat cars, to be distributed by the sectionmen or by a work-train crew. In some cases the loading of ties is contracted.

For rapid distribution the ties where possible should be loaded on flat cars, crosswise, except two under courses at each end. These courses should be placed lengthwise on the car, each course blocked under the outer end by a tie placed crosswise, to give a pitch toward the middle of the car. These slanting courses act as guards to keep the ties placed crosswise from being jarred or rolled over the end of the car. If in these slanting courses the two thickest ties of each course are placed on the outside, they will be held in place by the weight from above and no stakes will be needed.

The exact number of ties wanted for renewals in places can be known and the right number of new ties can be dropped off, just as well as not. Much useless handling and trucking of ties results from throwing them off by guess while distributing, for without some system of estimating or counting the number required and the number delivered there will usually be either too many or else not enough. Where ties are thrown off in excess of the requirements it is usually the case that many old ties which could profitably remain another year will be removed simply to make room for all of the new ties. On the other hand, if an insufficient number of ties is distributed in places, the deficiency must be made good by trucking, or else some old ties will remain in the track which ought to come out.

When ties are delivered in box, stock or gondola cars a strong force is needed to unload them promptly—say 25 or 30 men. On the average it takes four men about 30 or 45 minutes to unload a box car holding 300 oak ties. If the ties are loaded on flat cars a few men can tumble them off rapidly, and 15 to 18 men are a sufficient force.

The best way to control the number of ties put off when unloading from flat cars is to work the men in relays of a few men each. It is much easier to control the movements of a few men working rapidly than of a whole crew working at the ordinary gait. When unloading from flat cars four or five men besides one to tally are usually a sufficient force working at one time to do the unloading.

The train should not in general run faster than six miles per hour; and on high fills quite slowly, because in such places ties are thrown too hard will roll to the bottom of the slope. The foreman of the section whereon the ties are being unloaded or the supervisor or roadmaster should invariably accompany the train to advise as to the number of ties wanted and the exact location of the same. It is also well to have the section crew, or part of it, follow the train on a hand car, to throw out any ties which may have fallen too close to the track.

At narrow cuts it is a good plan to throw off the whole number in piles at each end of the cut, especially if the old ties are not to be taken out for some time, and the same is true for high, narrow embankments. Proper attention should be given to loading and throwing off the hardest ties for the curves. In distributing ties on curves observations should be taken of the side of the track from which the ties will have to be pulled in when making renewals, and the ties should be thrown off on that side. At all times, however, the ties should be so unloaded as not to require rehandling in order to remove old ties from track.

The question of using way-freight trains for tie distribution depends upon the traffic conditions. On roads where the local freight business is light it is found to be economical to send the ties out a few carloads at a time with these trains, to be unloaded in place by the sectionmen, who are previously notified to be on hand at the point where the ties are wanted. The delay to the train in waiting for the ties to be unloaded is necessarily considerable, and on roads where the local freight work is heavy the

way-trains are frequently or nearly always behind time, and the extra work of tie distribution is considered inexpedient. Such is also quite liable to be the decision where the ties are to be unloaded from box cars, or where a trainload of ties arrives and there is a demand for prompt release of the cars.

As a general thing ties distributed from a work train are put off in better shape than from a way-freight. The crews of the latter rush the work too fast, either by urging the men or by moving the train too fast for the men to properly unload the ties. An ordinary result of such haste is that ties are thrown down embankments, into bridge openings, or are so sparsely distributed that much time is lost in carrying them to place where renewals are made.

On roads where ties are handled by way-freight it is quite customary to begin the distribution as early as January, for the obvious reason that only a few carloads can be distributed each day, and it is necessary to take a good deal of time in order to get over the division by spring. Again, on roads where the ties are received from outlying sources of supply it is frequently the case that the distribution begins late in the fall, so as release the cars promptly and avoid piling the ties up in the yards. It is doubtful whether anything is gained in either case. In the first place, ties should not be unloaded and left lying on the ground through the winter, as in this position they gather moisture from the ground, are covered with snow or lie in ditches or wet places and become watersoaked, so that the germs of decay are well inducted before the ties see any service at all. In order to obtain all the advantage possible from seasoning, the ties that are received during the fall and winter, preferably, should be carefully piled at points exposed to the wind and sun, but it costs no more to do this in the yards and along sidetracks and to load them up again on flat cars in the spring and deliver them right where they are wanted, than it does to pile them up all along the right-of-way and then carry or truck them to place when the renewals are made. In the second place the practice of piling up new ties along the right-of-way, to remain three to six months before they are used, is contrary to principles of good policing. If the right-of-way is piled with new ties all winter and spring and with old ties all summer and perhaps most of the fall, there are but a few months when it presents a clean or finished appearance. In the third place, an accurate count of the ties to be renewed cannot be made until the time for renewing is close at hand, and then is the best time to make the distribution, unloading the ties where they are wanted, and so near the time they are to be used that they need not be piled.

When possible, all ties in any one car should be unloaded on the section on which car is opened. When ties are unloaded in piles, each pile should be distinctly marked with the car number.

Counting and Inspection.

The roadmaster, or his assistant, should, if possible, take charge of unloading ties when the work train is used, and see that a proper count and inspection are made. This count and inspection again should be verified by the section foremen going over the ties unloaded on their section, rechecking and reporting results to the roadmaster.

The general rules given above governing untreated also apply to treated ties.

In the case of zinc-treated ties, there seems to be a difference of opinion in regard to the piling. A number of railways which have used them very extensively believe that they should be piled in open piles similar to untreated ties, but a number of others that have gone into it from a more scientific standpoint, especially in the South, where the climate is warm and the seasons are long, think that by being piled in open piles their drying is so rapid that they develop checking, which is a serious objection to the wearing and life of the tie, and for this reason they are piling zinc-chloride ties the same as creosoted ties.

Treated ties should be handled with tongs. Creosoted ties in piles should be covered with cinders or earth to eliminate the danger of fire from sparks from passing engines. If treated ties, especially creosoted, are stored in large quantities a system of fire protection should be inaugurated.

L. A. Downs (I. C.), chairman; G. W. Merrell (N. & W.), vice-chairman; C. C. Albright (Purdue Univ.), W. A. Clark (D. & I. R.), E. D. Jackson (B. & O.), F. R. Laying (B. & L. E.), J. B. Myers (B. & O.), R. J. Parker (A. T. & S. F.), H. S. Wilgus (P. S. & N.), W. J. Burton (M. P.), S. B. Clement (T. & N. O.), E. P. Laird (A. C. L.), E. R. Lewis (D. S. S. & A.), J. V. Neubert (N. Y. C.), J. G. Shillinger (Rutland), Louis Yager (N. P.).

Discussion on Ties.

The report was presented by Chairman Downs.

The definitions presented by the committee were adopted.

Chairman Downs: The next subject is No. 2. Last year the committee made a report on this, and we asked that it be received only as information. This year we have a formula that we recommend for the Manual as economic comparison of railway ties of different materials. I move that this be adopted, to be printed in the Manual.

Mr. Sullivan: In the first paragraph C is taken to mean "first cost of tie in place," but further down, C has a different meaning.

Chairman Downs: We will alter that.

The President: The formula will be adopted for insertion in the Manual.

Chairman Downs: I move that the subjects on the use of metal, composite and concrete ties, and the distribution and care of cross ties be received as information. (The motion was carried.)

IRON AND STEEL STRUCTURES

The subjects assigned for investigation during the past year were:

(1) Report on the methods of protection of iron and steel structures against corrosion.

(2) Study designs and report on built-up columns, co-operating with other investigators and committees of other associations.

A. J. HIMES,
Chairman Committee on Iron and Steel Structures.

(3) Report on the design, length and operation of turntables.

(4) Report on the relative economy of various types of movable bridges.

Other subjects continued from the preceding year were:

(5) Investigation of secondary stresses and impact.

(6) Adaptation of designs of movable bridges to signal and interlocking appliances required.

(7) An elastic requirement for steel.

(8) Bridge clearance diagram.

A report on "Methods of Protection of Iron and Steel Structures against Corrosion" was submitted in Appendix A as information and without recommendation.

The study of built-up columns has continued throughout the year. The U. S. Bureau of Standards has furnished and tested 18 columns according to the plans and under the direction of the committee. A progress report was submitted in Appendix B which included the records of the above tests. It is expected that the Bureau will continue its generous co-operation with the committee and that further tests will be made during the ensuing year. The committee is in close touch with the special committee on Columns and Struts of the American Society of Civil Engineers and the work of the two committees has been supplementary and harmonious.

The "Design, Length and Operation of Turntables" has received considerable study and investigation. Much valuable information is being accumulated, but it is too early for the committee to make any recommendations. A progress report was presented.

The "Relative Economy of Various Types of Movable Bridges" has received much original study and experimental investigation. The data thus far accumulated has not yet been prepared for publication and the committee can only say that much progress has been made and that some very useful information will probably be available during the coming year.

A brief statement of progress in the study of "Secondary Stresses and Impact" was made. The committee is now contemplating a revision of the specifications with the purpose of making use of the experimental data heretofore accumulated.

At the last annual convention the "Adaptation of Designs of Movable Bridges to Signal and Interlocking Appliances Required" was referred back to the committee. The subject has received some discussion and information concerning current practices has been secured. Owing to a pressure of other work, no conclusions have been reached, and only a progress report was made at this time.

Sub-committee G prepared a very complete and careful statement of the need of an elastic strength requirement for steel, which was presented. Specifications were drawn for this requirement, and were recommended for adoption.

A report on the Bridge Clearance Diagram was also presented.

CONCLUSIONS.

The committee recommends that the following action be taken on the report submitted herewith:

(1) That the report on methods of protection of iron and steel structures against corrosion be received as information.

(2) That the report on the design of built-up columns be received as a progress report.

(3) That the report on the design, length and operation of turntables be received as a progress report.

(4) That the report on the relative economy of various types of movable bridges be received as a progress report.

(5) That the report on secondary stresses and impact be received as a progress report.

(6) That the report on the adaptation of designs of movable bridges to signal and interlocking appliances required be received as a progress report.

(7) That the specifications for an elastic strength requirement for steel be adopted and printed in the Manual.

(8) That the bridge clearance diagram shown be adopted by the Association and substituted for the diagram now published in the Manual; also that a footnote be added to the specifications calling attention to the recommendations of the Committee on Electricity for a clear height of 25 ft. in electrified zones.

A. J. Himes, chairman (N. Y. C. & St. L.); O. E. Selby, vice-chairman (C. C. C. & St. L.); J. A. Bohland (G. H.), W. S. Bouton (B. & O.), A. W. Buel (Cons. Eng.), A. W. Carpenter (N. Y. C.), Charles Chandler (I. C.), C. L. Crandall (Cornell Univ.), J. E. Crawford (N. & W.), F. O. Dufour (Interstate Commerce Commission), W. R. Edwards (Interstate Commerce Commission), A. C. Irwin (C. M. & St. P.), B. R. Leffler (N. Y. C.), W. H. Moore (N. Y., N. H. & H.), P. B. Motley (C. P. R.), Albert Reichmann (Am. Br. Co.), C. E. Smith (M. P.), H. B. Stuart (G. T.), G. E. Tebbetts (K. C. T.), F. E. Turneaure (Univ. of Wis.), L. F. Van Hagan (Univ. of Wis.).

APPENDIX A.

METHODS OF PROTECTION OF IRON AND STEEL STRUCTURES AGAINST CORROSION.

The study of this subject has been continued along the lines of further investigation into the protection by means of paint and protection by means of concrete encasement.

It is realized that the vast bulk of iron and steel structures are protected by means of paint and must continue to be protected by this agency until something more effective and equally economical is introduced. As paints are made of a variety of materials in many forms and combinations, the relative efficiency of which for the purpose under consideration has not been well established, there appears to be a field for usefulness on the part of the committee in pursuing the investigation of this line of protection.

Study of Principles Underlying the Choice of Materials for Efficient Paints.

Paints for the protection of iron and steel structures may be simple liquids, as drying oils; dissolved solids, as asphalt paints and coal tar paints; combinations of pulverized or finely-divided solids, known as pigments, and of drying oils, known as vehicles; and lastly almost any combination of any of the above. Varnishes, which are mixtures of gums and oils compounded by means of heat, are frequently introduced into the vehicles of paints.

The most important and extensively used paints are those which are mechanical mixtures of pigments and vehicles. The most important and common vehicle is linseed oil. Other vehicles are fish oils, china wood oil, soya bean oil and mineral oils. All of these except china wood oil have been frequently used as cheap and inferior substitutes for adulterations of linseed oil, although china wood oil, soya bean oil and menhaden (fish) oil are recognized as valuable assistants in certain paints. Turpentine and light mineral oils (such as benzine, benzol, naphtha, etc.) are used as thinners and solvents and are so used both legitimately and otherwise.

An oil paint generally requires, in addition to the pigment and the oil, a small proportion of dryer, which is generally a liquid which, when incorporated into the paint, causes the film of it to dry by oxidation with the desired rapidity. Films of other paints, such as asphaltum and coal tar paints, dry by the evaporation of the solvent.

It is quite generally considered that the most durable paints are those which are composed of pigments with linseed oil as the principal ingredient of the vehicle. Linseed oil varies in its composition and properties according to its method of extraction from the flaxseed, and its later manipulation. There is little or no choice nowadays to the consumer as regards the method of extraction from the seed, this being controlled by large commercial concerns whose methods are practically identical in that they all employ the hot-pressed method which possibly gives inferior oil to that obtained by the cold-pressed method. (Cold-pressed oil is obtainable commercially at a large advance in price (10 cents per gallon at time of writing) over raw oil.) After pressing, however, the oil is processed and refined by many methods and graded commercially accordingly. Raw oil and boiled oil are the two general kinds employed for structural metal paints and both of these are variously treated so as to considerably modify their properties.

Raw oil with drier added to it without heating has been sold as boiled oil—"bung hole" boiled or "chemically" boiled by those who understand the difference between this makeshift and true boiled oil which is heated to a relatively high temperature, and generally has driers added also. When heated in open kettles, which is generally considered the best method, it is called open-kettle boiled and there is supposed to be some virtue in having the heat applied by means of a wood fire under the kettle.

There is room for much difference in treatment and skill in manipulation in boiling oil by the heating process and this leads to many claims of superiority by different paint manufacturers for their particular and secret methods in this line. Just how much if any real superiority there is in these special-processed oils over the commercial open-kettle boiled, now readily obtainable of the large oil manufacturers, is difficult to prove or disprove. It is generally conceded that neither raw nor boiled linseed should be free from certain ordinary impurities in order to give the best results in paints. There is a great difference of opinion as to the merits of raw or boiled oil for paint-making purposes, but for metal paints the tendency seems to be towards the use of the open-kettle boiled oil.

As films of linseed oil-and-pigment paints are always more or less porous and pervious to water and moisture, considerable experimentation has been undertaken towards increasing the impermeability of the film by adding varnishes, bitumens and other kinds of oils to the linseed oil in certain minor proportions. If the proportions of these added materials become too great, the durability of the film is generally decreased on account of brittleness or otherwise.

The most extensive scientific study of the properties of paint materials probably has been made on pigments. For a long time paints have been known principally to engineers and others simply by the name of the pigment element, as iron oxide paint, red lead paint, graphite paint, etc., and it was long supposed that the pigment was the principal factor in determining the efficiency of these aints.

Pigments are commonly divided into two general classes, which may be called primary and secondary. Those in the primary class are the ones strong in color or in covering power and sometimes forming chemical combinations with the vehicles. Those of the secondary class are weak in color and covering, generally not suitable for use alone as pigments, but suitable as fillers and extenders when mixed with these primary pigments; these are commonly known as "inert" pigments, although this is really a bad designation, since many of the primary pigments are chemically inert to all atmospheric influences and to the usual paint vehicles.

The principal primary pigments used for structural metal paints are the following:

(1) White leads. (a) The basic carbonate, which is the kind made by the well-known Dutch process, and (b) the basic

sulphate, commonly known as the "sublimed" variety. (2) Zinc oxide or white zinc. (3) Red lead. (4) Blue lead. (5) Iron oxides, including Venetian red. (6) Lampblacks, generally the product of burned petroleum oils. (7) Carbon blacks, generally the product of burned natural gas. (8) Graphites, natural and artificial. (9) Ochres. (10) Natural carbons, slates, clays, etc., possessing peculiar properties fitting them for pigments. (11) Chrome greens and yellows, used generally for tinting only.

The cost of the above pigments will usually range from 2c to 10c per pound, except the chrome pigments which, when pure, are much more expensive. Pigments which are sometimes used, but are generally prohibitory on account of their high cost, are American Vermillion and other chromates and Prussian Blue.

The principal secondary pigments are: (1) Silica. (2) Asbestine. (3) Barytes (natural sulphate of barium). (4) Calcium carbonate, including chalks (frequently called whiting). (5) Clays. (6) Gypsum. (7) Blanc fixe (artificial sulphate of barium).

These are all cheap materials, usually costing under 2 cents per pound. When used they are mixed with the primary pigments to cheapen the product and often with definite ideas of improvement of the paint. For instance, a small percentage of calcium carbonate is said to counteract any free acid that may be present in the primary pigment; silica is thought by some to give a "tooth" for holding subsequent coats; asbestine and china clay aid in keeping pigments in suspension in the vehicles; barytes gives weight and body to paint; blanc fixe, used in large proportions in proper mixtures, is said to give excellent results for certain sea air exposures.

As before mentioned it has been generally thought for many years that the pigment is the ingredient which has the greatest influence on the durability and efficiency of paint coatings, especially those for the protection of steel surfaces, although paint technologists recognize the great importance of the vehicle and that the two must largely be considered together. So many pigments have been available and in so many variations and combinations that it has not been easy to determine their relative merits or the properties which are necessary for suitable pigments. The question of color often is the determining factor, especially when white and very light shades of color are wanted, for which the white leads and zincs must be used; but for dark colors almost any of the pigments can be used, tinting as required, even the white pigments. (It may surprise some to know that a black pigment can be produced by mixing 45 parts by weight, of white lead and 55 parts of carbon black.) Excepting the question of color, the present field of pigments may be said to be the survival of those found fittest by many years of trial. To further determine the relative merits of these pigments, many tests have been made by individuals, paint manufacturers, railroad companies, technical associations and other, with coatings made with these various pigments, applied both to test plates and to structures in service, exposed to various atmospheric influences and to artificial substitutes for them, and except for certain special conditions of application and exposure, without decisive results. Probably the most prominent of these tests are those of the American Society for Testing Materials and widely known as the Atlantic City and the Havre de Grace Bridge tests.

A circular letter was sent out to 67 different railroads in the United States and Canada. The circular made inquiry by means of several questions grouped under the headings of (1) shop coat on new fabricated steel; (2) field coats on new fabricated steel; (3) repainting or maintenance of bridges under traffic. Replies were received from 53. The following is a summary showing the extent of the use of each kind of paint as indicated by the replies; figures and percentages referring to individual railroads:

1. Kind of shop paint used:

Red lead pigment paint, 29 out of 50, equal to 58 per cent.
Linseed oil only, 5 out of 50, equal to 10 per cent.
Linseed oil, parts in contact after assembling with red lead pigment paint, 2 out of 50, equal to 4 per cent.
Linseed oil, parts in contact after assembling with various proprietary paints, 4 out of 50, 8 per cent.
Graphite and carbon pigment paints, including lampblack paint, 8 out of 50, 16 per cent.
Miscellaneous, 2 out of 50, 4 per cent.

2. Kind of paint (classified as to pigment) used for field coats on new steel:

Red lead straight or in part, 12 out of 48, 25 per cent.
Carbon or graphite or both, 24 out of 48, 50 per cent.
Miscellaneous, 12 out of 48, 25 per cent.

3. Kind of paint (classified as to pigment) used in maintenance:

Carbon, 13 out of 46, 28 per cent.
Graphite, 7 out of 46, 15 per cent.
Both carbon and graphite, 4 out of 46, 9 per cent.
Red lead straight or in part, 11 out of 46, 24 per cent.
Various, 11 out of 46, 24 per cent.

APPENDIX B.

COLUMN TESTS.

At the sub-committee's first meeting, July 10, 1912, after a discussion of the program of tests which had been arranged by the committee on Steel Columns and Struts of the American Society of Civil Engineers, it was decided to make drawings for a preliminary series of test columns to cover eight sections commonly found in the compression members of railroad bridges. It was planned to test a light and heavy section of each type made up in three lengths to give slenderness ratios of 50, 85 and 120. Three specimens of each column to be fabricated, making in all 144 test-columns for the series, which is designated as "Series No. 1."

James E. Howard, then engineer-physicist of the Bureau of Standards, stated on behalf of S. W. Stratton, director of the Bureau of Standards, that the Bureau would be glad to furnish the columns and make the tests, provided the subcommittee would furnish the detailed plans. It was expected that the 2,300,000-lb. Emery machine would have been completed late in 1912, but it was not in working order until about September, 1913. The fabrication of the columns was taken up in October, the first 18 columns were shipped to Washington in December and the first column of the series was tested in the presence of the committee on January 20, 1914. By October 15, 15 of the first 18 columns had been tested, and by November 30 all of the columns had been tested, and the complete test reports were received December 7. It will take at least three years more to complete the preliminary programs of the American Railway Engineering Association and American Society of Civil Engineers column tests. It is the expressed intention of the Bureau to carry on both sets of tests simultaneously.

It was the intention of the committee that the material should be rolled and the columns fabricated in accordance with the Specifications for Railway Bridges of the American Railway Engineering Association, but the Bureau, in ordering the first lot along with some columns for the American Society of Civil Engineers series, used the latter's very rigid specifications for this material. The difficulty of obtaining this material, in part, accounted for the delay in fabricating the columns. The material complied extremely closely with the specifications, being of very uniform quality, its weight per cubic in. being 0.2835-lb.

TABULATION OF PART OF TESTS, COLUMN I, SERIES I.

	No. of Test Piece	l/r	Nominal Section Sq. In.	Actual Section Square Inches	Failure lbs. per sq. in.	Method of Failure
1	12	50	9.56	9.55	37,930	
2	57	50	9.56	9.12	39,254	Failed by deflecting south and up.
3	74	50	9.56	9.29	38,200	Failed by deflecting south and down.
4	7	50	12.50	12.55	38,500	Failed by triple flexure.
5	72	50	12.50	12.45	37,765	Failed by buckling down and north.
6	73	50	12.50	12.48	35,380	Failed by buckling down and north.
7	17	85	9.56	9.636	32,860	Failed by triple flexure.
8	58	85	9.56	9.12	35,000	Failed by triple flexure buckling in center.
9	61	85	9.56	9.38	34,093	Failed by deflecting north and up.
10	20	85	12.50	5.92+5.73=11.65	34,060	Failed by triple flexure buckling in center.
11	60	85	12.50	11.83	34,937	
12	62	85	12.50	12.45	34,000	
13	29	120	9.56	9.42	33,020	Failed by triple flexure buckling n center.
14	55	120	9.56	9.54	32,000	
15	66	120	9.56	9.45	34,000	Failed by deflecting south and up.
16	25	120	12.50	12.28	32,565	Failed by triple flexure ibuckling in center.
17	67*	120	12.50	12.34	29,000	
18	68	120	12.50	12.39	30,863	

*Before testing, Column No. 67 was found to be bent down 0" .21 and south 0" .07.

Note.—The length of the column was assumed to be the total length between the milled end of the channels composing it. The actual sections are found by carefully weighing the channels, as it was found impossible to get very accurate results by calipering, or even by using the planimeter on imprints of the ends of the sections.

The sub-committee now proposes, instead of proceeding to Section No. 2 of the series, to make a sub-series of tests on Section No. 1, varying a detail at a time, in order to study the effect of the details on the strength of the column. Dr. Stratton assures the sub-committee that he will proceed to obtain the columns for these sub-series and test them as rapidly as possible.

APPENDIX C.

DESIGN, LENGTH AND OPERATION OF TURNTABLES.

The changes in railway structures and facilities due to the rapid increase in the weight and length of locomotives in recent years is not more marked anywhere than in the case of turntables. In 1895 the ruling length of turntables was perhaps 65 ft.; in 1915 it surely will be 85 ft. or more, thus showing in increase of 1 ft. per year. The increase has been quite uniform, but, of course, not in 1-ft. increments, the changes in length being made usually 5 ft. at a time. The increase in strength has kept pace with the increase in length, but both have fallen behind the proper requirements of the heaviest locomotives for the reason that a turntable failure does not result in disaster, but only in inconvenience and delay, and naturally the tendency is to get along with the old as long as possible rather than incur great expense for new.

In 1913 the committee caused to be sent to the membership a circular letter of inquiry concerning current and recommended practice in regard to ten of the principal features of turntable design. Length is, of course, the primary feature of design. Eighty-one per cent. of the replies gave 80 ft. or more as standard practice and 87 per cent. gave 80 ft. or more as the length recommended for ordinary road engines. Sixty-five per cent. of the replies favor either 85 or 90 ft. The conditions which determine the length of the turntable are the length of wheel base of the longest locomotive to be turned and the position of its center of gravity. For ease of turning the locomotive should be balanced, and for determining the length, the most unfavorable condition, that is, with the tender empty and the boiler filled, should be assumed. The length required then becomes twice the distance from the center of gravity to the rear tender wheel, with an arbitrary addition of, say, 1 ft. at each end for margin to facilitate spotting and to clear wheel flanges.

The question of designing turntables to be turned by power without balancing, in order to reduce the length necessary, has received some attention. Many turntables are so operated because they are too short to balance, but they are not designed for such operation and the result is a large expenditure of power and unsatisfactory service. This method of operation will require especially heavy and carefully designed end bearing journals and other features not common in present practice.

A table 85 to 90 ft. long will be long enough to balance most of the heavy freight and passenger engines exclusive of the Mallet type and a 100-ft. table will be required for roads which find it necessary to turn ordinary Mallet engines.

Type.—The replies indicate that the deck type is used and preferred almost to the exclusion of the through type. Only four roads indicated a preference for the through type. One of these gives as reasons, drainage, economy of pit construction and economy of time in reconstruction of the center at busy terminals. The other three roads give no reasons, but the above three are the ones commonly cited together with the one that the shallow pit of the through type is less subject to obstruction by snow.

Drainage is not a controlling feature if the turntable is at a modern engine house with drop pits, because the drainage necessary for the drop pits will take care of any reasonable depth of turntable pit. Economy of pit construction is in favor of the through type, but the increased weight and cost of the turntable neutralize part of it. The shallow pit also is conducive to safety, but this is partly offset by the hazard of narrow clearances and knee braces inside the through girders.

The economy of time in reconstruction of the center foundation does not exist in the case of a new location, and it may not be realized in the case of the renewal on an old center if the old center foundation requires reinforcement to carry the added load.

Obstruction by snow may be minimized in either type by providing ample space throughout, not less than 18 in., between the bottom flange of the girders and the pit floor.

Type of Center.—The majority in both practice and preference favor roller centers. Only 7 roads replying use disc centers, but 11 indicate a preference for that type. The disc center has been greatly improved in recent years and has advantages which entitle it to be thoughtful consideration. The roller center has the advantage of ease of turning. The disc center has few and simple parts, but is conceded to require more power to turn. This disadvantage is minimized by the fact that practically all heavy modern turntables will be equipped with power and the cost of the power consumed is negligible. Some tests which were made recently of the power required to turn a number of both disc and roller center turntables show that in the worst cases the power cost, including tractor losses, does not exceed ½ cent per 180 deg. turn. The first cost of the two types is about the same, if designed on similar specifications.

Good practice requires low-unit pressures on both types. For roller centers the pressure in pounds per linear inch of roller from full live and dead load on the center should not exceed 400 times the diameter of the rollers. This is exceeded in many centers in use, and much of the trouble in maintenance is attributable to too high unit pressures. For disc centers practice has varied from 3,000 lb. per sq. in. down to 1,500. The latter figure produces a very large disc and increases the lever arm of the frictional resistance unnecessarily. High unit pressures increase the difficulties of lubrication and pressures much in excess of 3,000 lb. per sq. in. have caused failures in the bronze discs. It has been found that a hard phosphor bronze, which will not flow under the pressure used, gives good results.

End Lift.—The most damaging thing in the operation of a turntable is the hammering of the ends by entering wheels. It has been proposed to reduce this damage by means of end lift or shock-absorbing devices. The replies indicate that only 4 roads replying use such devices and 15 consider such a device necessary. Where successful, they have been very expensive. Standard practice cannot be said to include them. Undoubtedly more liberal design of end bearings and better circle rail support will do away with the necessity for such devices to a great extent.

End Latch.—One-third of the roads replying use end latches and about half of them consider them necessary, or, in other words, one-sixth have them in use, but do not consider them necessary on power-operated turntables. The best designs for latches have a heavy sliding tongue connected to the girders by a breakable connection and engaging cast-iron sockets set in the pit wall. Preferably there should be a latch at each end. The latch should not be attached to any part of the track or track fastenings or deck.

Type of Deck.—The use of timber cross-ties is almost universal, although a few through turntables have been built with steel plate floors on I-beams. Eight of the replies express a preference for I-beam decks, and possibly more would have done so if there had been familiarity with that type of construction. A deck of transverse I-beams riveted between the girders just under the top flange has the advantages of permanence and rigidity without prohibitive cost. It also permits of greater depth of girder than the superimposed timber deck, but this advantage is shared with a timber deck similarly placed. In both cases the sidewalks are carried on riveted brackets outside the girders and independent of the track floor.

Live Load.—No single feature of the replies shows wider variations than the live load used for designing. The center loads vary from 312,000 to 720,000 lbs. Certainly the load should not be taken at much less than 500,000 lbs. where Mallets are not used, and justification can be found for loads from that up to 700,000 lbs. where Mallets are used. The 720,000-lb. center load reported is not an engine load, but results from the use of an arbitrary uniform load.

The center bending moments for one girder due to live load vary from 951 to 4,375 thousand foot-pounds. A great number of the replies indicate the use of some form of long wheel base consolidation or Mikado type locomotive giving a bending moment of from 2,000 to 2,500 thousand foot-pounds. Twenty out of 48 replies are between those limits. A surprising number indicate the use of some one of Cooper's series, which seems to betray lack of careful consideration of the matter on the part of those replying.

Unit Stresses, Impact and Deflection.—The permissible unit stresses are determined by the permissible deflection, and the two subjects should be considered together. Unit stresses, which would be entirely safe against failure, might permit excessive deflection of the ends and produce an unsatisfactory result. The replies as to permissible deflection probably are of little value because it is evident that the clearance over the circle rail has been confused with the deflection. From those replies on which this distinction seems to be understood clearly, it appears that the permissible deflection, measured at one end with the other end down on the rail, should be limited to from ¼ to ¾ in. The wheels of the loaded turntable should stand well clear of the circle rail at each end, not less than ¼ in.

The unit flange stress in tension used varies from 8,000 to 12,000 lb. per sq. in. without impact, and 21 out of 48 replies

give 10,000 as the permissible stress. The turntable should be designed so that the sum of the deflections at both ends will not exceed one one-thousandth of the length of the turntable and so that the unit tensile stress will not exceed 10,000 lb. per sq. in. The reversal of stress, which occurs near the center of each arm, should be provided for in accordance with the specifications for steel bridges. Provision for the reversal has the effect of extending the heavy flange sections toward the end and the heavy web requirements toward the center, which is beneficial as it increases the mass and stiffness of the girders. Parts not contributing to the end deflection of the girders may be designed by ordinary structural unit stresses, say 16,000 lb. per sq. in. tension. One condition of loading not often taken into account is that of a dead engine being pushed across the turntable by another engine. This condition is especially severe on the web and the stresses should be investigated for each design. Inasmuch as the turntable is not turned with such a load the higher unit stresses will apply.

Pit.—The hammer blow from wheels entering and leaving the turntable is especially severe on the circle rail and shore rail supports. Designers who have given attention to these details and their improvement are divided in opinion between a timber support for the sake of elasticity and an unyielding support on metal and concrete. More than 40 per cent. of the replies favor metal and concrete supports for the circle rail and more than 25 per cent. favor it for the shore rail support on the edge of the pit, indicating that this form of construction is growing in favor, as not many years ago the use of timber was universal.

APPENDIX E.

ELASTIC STRENGTH REQUIREMENT FOR STEEL.

The general specifications for steel railway bridges contain no elastic strength requirement for the steel otherwise specified. The only reference to the elastic strength of the materials is in the clause reading: "The yield point, as indicated by the drop of beam, shall be recorded in the test reports."

In 1901 the committee on Iron and Steel Structures presented certain specifications for structural steel as a basis for discussion and criticism at the annual meeting of the association. Two grades of structural steel were proposed at that time and a minimum value was fixed for the tensile yield point for each grade. In 1903 revised specifications were presented, calling for a single grade of structural steel with a specified range of ultimate tensile strength, and no definite requirements as to the yield point, but with the clause relative to this point as in the present specifications and as noted above. The opposition to the omission of the requirement was so strong that the specifications were not adopted at that meeting, but were referred back to the committee. They were presented again at the meeting of 1904, identical as regards the yield point, and the printed record of the Proceedings shows no discussion of this feature in the meeting, although there was a written discussion which questioned the propriety of dropping the yield point requirement. The specifications were adopted by the Association by a majority vote at the 1904 meeting.

Following the Quebec Bridge failure in 1907, the superimportance of the elastic strength over the ultimate strength in structural steel, especially for compression members, was so emphasized that it is to-day axiomatic. The question occurs: Is it not dangerous to subordinate such a critical property to less important and misleading ones among those which are determined for the acceptance of material?

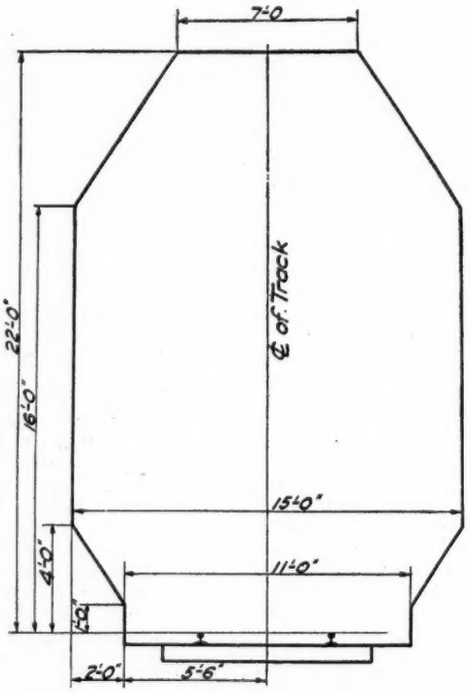
These considerations have led to an agitation for the restoration of an elastic strength requirement in specifications in which it has been omitted. The standard specifications for structural steel for bridges of the American Society for Testing Materials, which had previously been identical with those of the A. R. E. A. as regards the elastic strength requirement, were revised in 1913 to provide a yield point requirement. This sub-committee believes that the time is opportune for this committee to consider this question.

This sub-committee is of the opinion that the general specifications for steel railway bridges should include an elastic strength requirement that the yield point is the correct indication of the elastic strength and that the specifications should require a yield point not less than 30,000 lb. per sq. in. for structural steel, and not less than 25,000 lb. per sq. in. for rivet steel.

APPENDIX F.

BRIDGE CLEARANCE DIAGRAM.

Bulletin No. 163 of the Association published the replies to a circular letter, which indicate that the majority of the railroad engineers are in favor of increasing the width of the clearance diagram. In order to secure more detailed information as to the prevailing clearance diagram in use on the various roads limiting the size of equipment, and also to obtain information as to the size of the largest existing equipment, a letter was sent to the members of this committee and to several chief engineers of large railroad systems. After an extended discussion, a revised clearance diagram was



Proposed Clearance Diagram.

adopted for presentation to the Association. This diagram has been shown on the accompanying plan. There has also been placed on the plan a footnote calling attention to the recommendations of the committee on Electricity calling for a clear height of 25 ft. in electrified zones.

Discussion on Iron and Steel Structures.

The report was presented by Chairman Himes. Conclusion (1) was received as information.

C. E. Smith (Mo. Pac.): Many tests have been made of various kinds in Subject 2, in which the variables have been so numerous that a difference of behavior could not be assigned to a specific case. In the tests which we have underway we propose to work one detail at the time so that when we get through we will know what was the cause of the difference in behavior.

Chairman Himes: We are very fortunate in being able to secure the co-operation of the Bureau of Standards on Subject 2. This is submitted as a progress report, and I move that it be accepted as such.

(The motion was seconded and carried.)

O. E. Selby (C., C., C. & St. L.): The report on turntables is submitted as a progress report only. In the matter of length there has been a progressive increase in the requirements for some years. They seem to have gotten up to something like 85, 90 or 100 feet. It is important to decide whether we are to recommend two different lengths of turntable, or one standard length. The committee would like to ask the attention of the convention particularly to the features of length, live load, and unit stresses.

W. H. Courtenay (L. & N.): As to the first item, that of length, it seems to me that is hardly a matter for this association to decide—that is a matter which will be fixed by each individual railway company.

J. G. Sullivan (C. P. R.): The chairman of the sub-committee has given information we have all been looking for; a general idea of the lengths of turntables the roads are going to. It would be well in addition to this information to get some data as to different types of heavy locomotives in use, and how much room they must have so that they can be turned when the tank is full of water and when there is coal on the engine.

Mr. Courtenay: As to live load, it seems to me that the cooper intact is not generally figured on. Any one who has the care of turntables knows that turntables are subject to end shocks, being struck endwise by engines. My experience is that it is necessary to have the turntable stiff, and they

should be figured for an impact provision at the outset; very low working stress and stiffness is an important consideration with turntables. They should be particularly stiff laterally, with ample spacing and lateral bracing.

Mr. Smith: A large number of the roads are using Cooper's loading. The overload on the turntables for the ordinary Mikado engine is practically 80 per cent over and above the stresses given by Cooper's loading. It works in the other direction in the turntable than it does on a bridge. We have just completed the design of a 90-foot turntable to replace a 75-foot turntable. We made four designs. One was a 90-ft. complete deck design, giving a distance of 9 ft. from rail to top of center. Another one was double I-beam, flush type of girder, level with top of rail, to fit the center now used by the 75-ft. table. Another one was half through, with the girders half and half above the rail, the girders 13 ft. center to center, and the fourth a straight through type, girders about 16 ft. center to center. Leaving out the item of drainage, there is very little difference in the cost of the four designs, they all figure about $12,000 for the table and center, without tractor and without piles. The pile foundation costs about $1,000 more. The tractors will run $500 to $1,500 more, so in round figures a 90-ft. table will cost from $14,000 to $15,000, without drainage. To have a 90-ft. deck type turntable will require a 19-ft. pit, to be installed, to replace the 70-ft. table with the 6-ft. pit, and the increased pit will render heavy expenditure necessary for drainage in many cases.

F. E. Schall (Lehigh Valley): We are designing our tables for Cooper's 60-ft. load, but we interpose a uniform load, so as to make the action of the cantilever of sufficient section to stiffen the table something like a 6,000-lb. to the lineal foot, and then we are using regular bridge requirements with 100 per cent impact. I think the committee should be asked to fix the unit stiffness to be adopted for turntables.

C. H. Cartlidge (C., B. & Q.): We have found for general purposes in a through type table that building the turntable as a frame structure and not as a girder is the more economical. I agree with Mr. Smith that it is useless to try to design according to the Cooper classification. A turntable is necessarily designed for particular service, and it is very easy to design it for the engines which are to be placed on it. A combination of two very different services is required —a turntable must deflect very slightly, and low unit stresses should be used for all members which are directly concerned in the deflection. Other parts in a through table, whether a through girder or a through truss may be designed with high unit stresses, with resultant economy in the floor system throughout, and the floor system is a large part of the total weight. Proceeding along these lines our experience has been that a turntable such as Mr. Smith described, 90-ft. long for the heaviest power we run, will cost about $10,000 with a pit of a depth of not over 4.5 ft. deep in the center. I would suggest, in connection with the designing of turntables, that it is within the province of this committee to make designs for pits, ring wheels and center bearings as well as the turntable itself.

C. F. Loweth (C., M. & St. P.): I think that the committee should confine itself to giving requirements for different lengths of turntables and if it does this the different railroad companies can very readily determine what is the proper length for them to use in special cases. In almost every case it is a special thing when you come to the matter of turntable length.

The President: The recommendation that this be accepted as a progress report is before you, and if there are no objections it will be so received.

(The fifth subject was received as a report of progress.)

C. E. Smith (Mo. Pac.): Regarding the sixth subject, both mitered and square-end rails with easer bars have given entire satisfaction for drawbridge connections on heavy traffic lines when properly maintained, while both designs have also caused trouble when not properly maintained. On account of the comparatively uneven surface offered by the mitered ends they ride more smoothly and quietly than the square ends and the reduced pounding causes less wear and less danger of breakage. As the wearing surface of the easer bar or sliding tongue used with square ends must of necessity be outside the rail head the bearing of the wheel tread is widened for the short distance through which the easer bar carries the wheel over the joint. The resultant pounding rapidly wears down both the rail ends and the easer bar and causes hard, noisy track. Regardless of the type of rail and connection creeping must be absolutely avoided either by the use of a sufficient number of anti-creepers or by inserting switchpoints in the track at the proper places.

Hunter McDonald: The appliance Mr. Smith referred to has been in use on two drawbridges on our lines for about four years. On one of them we have about 60 trains a day. It was developed as a result of complaints on the part of the signal department that they could not interlock the easer rail, and that the split rail raised up was not a safe device. The split switch is fastened to the stock rail by means of a permanent cuff, it cannot separate more than 1-16 in., so that there is no danger in using the split points in the main line under these conditions. As soon as the stock rail is driven home into the socket prepared for it, on the fixed span a hollow block is driven behind it by means of a signal which holds it in position. I can only say that since we put it in about four years ago, our expenses for repairs have been about seven dollars. One was installed on a drawbridge 397 ft. in length and the other on a drawbridge 365 ft. in length, the latter being open three times a day and the former being open about three times a week.

Mr. Carpenter: I would like to offer this motion on the interlocking of the signal and bridge functions: The bridge operating functions shall be interlocked with the signal system in such a manner that none of the functions for opening can be performed until the signals have been set at stop indication and so that the signals cannot be set at proceed indication until all of the functions for closing have been completed. The bridge operating functions shall be interlocked with each other so that they must be performed in a predetermined order, both for opening and for closing:

T. S. Stevens (A., T. & S. F.): I would like to see that motion changed to require that the home signals shall display the stop indication.

C. E. Lindsay (N. Y. C.): I think the case would be covered if we say "until the signals controlling the movement of trains over the draw have been set at stop indication."

Mr. Carpenter: This will be considered simply as the sense of the convention.

Mr. Loweth: I do not understand that the motion offered provides that all draw bridges shall be interlocked. If it does I should be opposed to it. It seems to me that there are many bridges where the necessity for interlocking is not apparent.

(The motion of Mr. Carpenter as amended by Mr. Lindsay, was then put to vote and adopted.)

Chairman Himes: The next subject on which we will ask to report is on an elastic requirement for steel. We present a proposed revision of that specification. I move the adoption of the revision.

(The motion was seconded and carried.)

Mr. Carpenter: In order to carry that revision through the specifications consistently, we should have added a proposal to modify paragraph 163 of the General Specifications to Steel Railway Bridges, which refers to the Full Sized Tests of Eye-bars, as follows:

"In eye-bar tests, the minimum ultimate strength shall be 55,000 lbs. per sq. in., and the minimum yield point, as indicated by the drop of the beam or of the mercury column of the testing machine, shall be 29,000 lbs. per sq. in. Bars shall generally break in the body and the fracture shall be silky or fine granular, should a bar break in the head and develop the specified elongation, ultimate strength and character of fracture, it shall not be cause for rejection, provided not more than one-third of the total number of bars break in the head."

C. H. Cartlidge: I would like to ask the committee if it is decided as to whether 29,000 lbs. is the maximum minimum. Cannot they get a 30,000 lb. limit about as easily as 29,000 lb.? It is my experience that it is possible to get as high an elastic limit in eye-bars as we specify for the ordinary material in the same structure.

A. F. Robinson (A. T. & S. F.): I think we should let the elastic limit in the sample tests go in just as it is, and leave the other parts for further consideration. I do not think we ought to take quick action on the matter.

Mr. Carpenter: I do not understand that there will be any difficulty in obtaining the 29,000 lb. minimum proposed with the full size eye-bars. It seemed consistent and rational to drop the limit for the yield point of the full sized test a little below that for the specimen test.

Thomas Earle (Pa. Steel Co.): I know you will have difficulty in many cases in meeting the 29,000 lb. in your full sized test, where you only specify 30,000 lb. in your specimen test, and it also must be evident that if the grade is to be picked out and separated by the manufacturer, so as to obtain these results, while you may not see it, it is certain that you will pay the extra expense.

Mr. Selby: I think it is common practice with manufacturers whether specified or not, to pick out the higher grades of steel within the range of ultimate strength required by specimen tests and manufacture their eye-bars out of this steel.

Mr. Carpenter: I present the matter as a motion for adoption by the Association.

(The motion was carried.)

Chairman Himes: The next subject which we were to con-

sider, continued from last year, is the bridge clearance diagram. It is not a general clearance diagram. It is a diagram that is recommended for iron and steel structures for bridges and is 15 feet. If adopted it would mean that that was recommended by the Association as good practice, and it would be presumed that in future construction this clearance diagram would be followed. It is largely a question for the Association to decide whether they want to change the clearance diagram, and if they do whether this change is satisfactory. It is the recommendation of the committee that this diagram be adopted, and I so move.

Mr. Schall: The Manual specifies 14 ft. in the clear, and if you make an analysis on the 13 ft. standard space which is now adopted by the Association, you will find that on a 6 deg. curve, with a 45-ft. car, passing on multiple tracks, on which a train is moving and the other is at a standstill, you will have 1 ft. 9 in. clearance, or the same clearance as you will have on a straight track on a bridge built for 14 ft. clearance. If you have a four track system you will have to provide for two lines of trestles and make the track spacing 18 to 19 ft. centers, and it will cost a lot of money. What are you going to gain? We have freight cars 10 ft. 6 in. wide, and 14 ft. 11 in. or 15 ft. high. You have not gained anything except you are producing a lot of trouble for the eastern roads, who have tunnels of small capacity.

Mr. Loweth: I represent one of the western roads, and I know that we do not want this clearance. The standard clearance now in the specifications is 14 ft. and I think that is as far as this Association should commit itself.

Mr. Courtenay: If this Association increases the clearance from 14 to 15 feet it will encourage legislatures, and anyone who has been before them, to try to stop some of this erratic legislation knows that they don't know much about matters affecting railroads. I think this would be a dangerous thing.

H. T. Porter (B. & L. E.): I have made some investigation of the question of clearance and I have come to the conclusion that we cannot get what you call safe clearance unless we go to 16 ft. There are trainmen who can hang on the side of box cars, with 16 ft. clearance and hang out far enough to be rubbed, and 15 ft. clearance might reduce the accidents and might not, and if the bridge is wider the chances are they will be less careful.

C. E. Smith (Mo. Pac.): If our predecessors had adopted this same attitude, undoubtedly we would to-day be building bridges 11 ft. wide, with 14 ft. overhead clearance. I think the Association should anticipate the fact that increased clearance is going to be insisted upon and grow up to it. I am not prepared to recommend any larger diagram than that, but hope the diagram recommended by the committee will be adopted.

Mr. Robinson: I think we ought to leave the diagram just as it is, 14 ft. and if the various railway commissions or parties in control of these matters want to call for increased widths in certain states we can give it to them, but I don't think we ought to increase it above 14 ft.

Mr. Churchill: The recommendation of the committee, as I understand it, is largely based on the requirements of some of the state laws. Those state laws do not place the limit on cars but on another part of the equipment. A large portion of the engine cabs now used is wide enough to require a greater clearance than 14 ft. at bridges, under the state laws. The Ohio law reads that the clearance shall be 1 ft. 6 in. outside of the widest equipment, and 14 ft. does not comply in that case. It is a question of whether we should put that on record as the action of this Association. The fact still remains that many of the roads must build bridges 15 ft. clear.

C. H. Cartlidge (C. B. & Q.): It seems to me that it ought to be remembered that what the Association has adopted in the past and what it has now printed in the Manual is not a recommendation for the maximum clearance, but a recommendation of minimum clearance. Anyone who has conditions requiring larger clearances is completely at liberty to provide such larger clearances. The danger in adopting enlarged minimum clearance is very real.

E. A. Frink (S. A. L.): I think there is a great deal more to this subject than that. If there was any prospect of widening the clearance that would cure the evils that we anticipate, I think it would be well, but I don't think there is any. I think the width of the cars and other equipment will have to follow the widening of the clearance. It has taken us a good many years to get a right-of-way that will carry our equipment. When you widen the track you will have to get wider cars, and that will mean a heavier load per ft. for the equipment, and you know what that means on bridges.

Chairman Himes: It seems that there is a strong desire on the part of some members to set up a templet on the railroads that will throttle the capacity of the railroads and will not permit the passage of large equipment. It is fair to presume that the reason we are using larger locomotives and heavier, stronger cars is because by so doing we can handle the traffic more economically, and it is for the purpose of making money. Now, if by building greater locomotives and greater cars the road can earn enough more money to pay for the structures they want to take down and renew, it looks like pretty good business to do so. It is clear that there has been a little mismanagement in permitting a perpetual see-saw between the engineering department and the motive power department, by which we get larger bridges and so on at a great waste of money, but that is not a problem of engineering. I think the idea that we must so erect our structures that we will throttle the development of the motive power department, and the equipment department is entirely wrong. Second, in regard to the danger: I don't think that it is a matter for us to consider what the custom in the past has been in regard to the clearance diagram. We have to consider the element of safety to those who operate the railroad. (The chairman's motion was put and lost.)

RAIL

The subjects assigned for investigation and report are as follows:

(1) Recommend standard rail sections.
(2) Continue investigations of rail failures and deduce conclusions therefrom.
(3) Continue special investigation of rails.
(4) Present specifications for material in rail joints.

STANDARD RAIL SECTIONS.

The present A.R.A. sections "A" and "B" were adopted in 1908. We were instructed by the American Railway Associa-

J. A. ATWOOD,
Chairman Committee on Rail.

tion to study these sections and submit a single type for standard.

During 1908 and 1909 very little rail of the A.R.A. sections was laid, and, generally, it has not been laid in such manner as to give comparative results of the value of the two sections; in fact, up to the present time there have been but three places the committee has knowledge of where the "A" and "B" sctions were laid in order to secure comparative results under similar track and traffic conditions. The matter of sections has been under consideration since 1908 and, owing to the lack of information giving comparative results, the committee has deemed it desirable not to be hasty in submitting new sections.

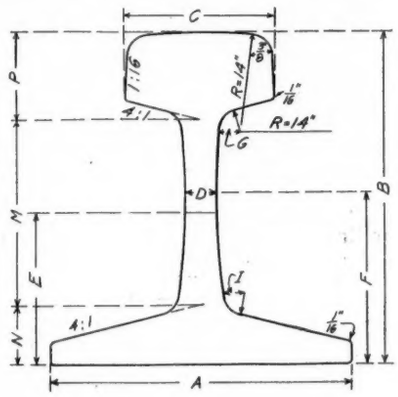
Tentative sections proposed by several members of the committee were submitted to the whole committee. These were criticised by members of the committee, and as a result there is now submitted for approval sections for rails weighing 100, 110, 120, 130 and 140 lb. per yd.

Suggestions have been made to the committee that a common fishing space should be used for more than one section; also, that a common width of base should be used for more than one section. To use a common fishing space for more than one section would result in a greater sacrifice in design-

ing some of the sections than seems desirable. To do so would be sacrificing one of the most expensive parts of our track, in order to help out a much less expensive part, and would appear to be a violation of the economical or theoretical principles which should control our work.

A common base for more than one weight of rail is less objectionable, and the only feature in the design that would necessarily be sacrificed would be the matter of stability against overturning. It seems desirable, however, to propose different widths of base for each of the sections recommended.

The designs submitted have kept in view the feature of the rail as a girder, and we have kept in mind a design having the



DIMENSIONS OF PROPOSED R. E. RAIL SECTIONS

Section	90-lb.	100-lb.	110-lb.	120-lb.	130-lb.	140-lb.
A	5-1/8"	5-3/8"	5-1/2"	5-3/4"	6"	6-1/4"
B	5-5/8"	6"	6-1/4"	6-1/2"	6-3/4"	7"
C	2-9/16"	2-11/16"	2-25/32"	2-7/8"	2-15/16"	3"
D	9/16"	9/16"	19/32"	5/8"	21/32"	11/16"
E	2-35/64"	2-3/4"	2-53/64"	2-59/64"	3-1/32"	3-9/64"
F	2-29/32"	2-31/32"	3-1/8"	3-1/4"	3-3/8"	3-1/2"
G	3/8"	3/8"	3/8"	3/8"	1/2"	1/2"
I	3/8"	5/8"	5/8"	5/8"	3/4"	3/4"
N	1"	1-1/16"	1-1/8"	1-3/16"	1-7/32"	1-1/4"
M	3-5/32"	3-9/32"	3-13/32"	3-17/32"	3-11/16"	3-27/32"
P	1-15/32"	1-21/32"	1-23/32"	1-25/32"	1-27/32"	1-29/32"
Actual Weight (lb.)	89.96	101.49	110.36	120.87	129.64	138.52
Area Head (sq.in.)	3.20	3.80	4.04	4.40	4.63	4.93
Per Cent	36.2	38.2	37.4	37.1	36.4	36.3
Area Web (sq.in.)	2.12	2.25	2.49	2.69	3.02	3.28
Per Cent	24.0	22.6	23.0	22.7	23.8	24.1
Area Base (sq.in.)	3.50	3.90	4.29	4.76	5.06	5.37
Per Cent	39.8	39.2	39.6	40.2	39.8	39.6
Total Area (sq.in.)	8.82	9.95	10.82	11.85	12.71	13.58
Moment of Inertia	38.7	49.0	57.0	67.6	77.4	89.2
Sect. Mod., Head	12.56	15.1	16.7	18.9	20.8	23.1
Sect. Mod., Base	15.23	17.8	20.1	23.1	25.6	28.4
Ratio M.I. to Area	4.39	4.92	5.27	5.71	6.09	6.56
Ratio Sec.Mod.to Area	1.42	1.52	1.55	1.59	1.64	1.70

Proposed R. E. Rail Sections.

highest ratio of section modulus to area of section. The radia of the fillets between the head and web, and web and base, have been made as large as possible without interfering with the bearing of the joint bars.

Although the committee submits designs for sections weighing 130 and 140 lb. per yd., it does not consider them necessary, nor does it recommend them for adoption. They should be received as embodying the ideas of the committee in regard to such sections, and are a development along the lines of the sections 100 to 120 lb., inclusive.

The committee offers no new designs for sections under 100 lb., and for the 90-lb. section recommends the A.R.A. "A" section for the single type standard. The sections now in general use do not vary sufficiently from those that might be submitted as to make any marked difference so far as mill practice or wear in service are concerned, the distribution of the metal in sections of 80 lb. and under being such that it cannot be varied, except in minute details that will not affect the life or safety of the rail in service.

SPECIAL INVESTIGATION OF RAILS.

During the year special reports have been prepared and presented to the rail committee, as follows:

Influence of Carbon on the Properties of Rails, by M. H. Wickhorst.

Formula for Deflection of Rails in Drop Test, by M. H. Wickhorst.

Study of a Rail with Internal Fissures, by M. H. Wickhorst.

Comparative Service Test of 100-Lb. Sections, P.S. and A.R.A.-A on the Pennsylvania Lines West of Pittsburgh, by W. C. Cushing.

Influence of Finishing Temperature on Open-Hearth Rails, by M. H. Wickhorst.

Internal Fissures in New Rails, by M. H. Wickhorst.

SPECIFICATIONS FOR MATERIAL IN RAIL JOINTS.

The following specifications are presented for adoption:

(a) Specifications for High Carbon Steel-Joint Bars.

(b) Specifications for Heat-Treated, Oil-Quenched Steel-Joint Bars.

(c) Specifications for Medium Carbon Steel Track Bolts with Nuts.

(d) Specifications for Heat-Treated Steel Track Bolts with Nuts.

RAIL LENGTHS.

The question submitted to the committee was the advisability of using rails longer than 33 ft. The question may be considered in several parts, as follows: (1) The most suitable length of rail from the track standpoint; (2) the transportation of longer rail; and (3) the manufacture of longer rail.

With longer rail the advantages would be in better riding track, and the saving in the number of joints and in the labor of applying and maintaining them. From the standpoint of securing the best track, it is desirable to use the greatest length of rail, the necessary expansion for which will not increase the pounding at the joints, or materially increase their cost of maintenance. This is principally a question as to what maximum expansion per joint can be used. Rail specifications permit a variation of $\frac{1}{32}$-in. from square at the ends, which tends to increase the length of expansion space used above the amount prescribed. Some manufacturers mill the ends, which eliminates this trouble; and this would be especially desirable for longer rail. While the best track cannot be secured nor the lowest maintenance cost reached unless the expansion space is uniformly distributed, and kept so, this would be more important with longer rail. Some think the expansion space now generally prescribed could be reduced; from this standpoint, any reduction would permit a relative increase in the length of rail that could be used, and it is desirable to have this carefully investigated.

The disadvantages would be the increased expansion space at the joints and the increased difficulty of handling longer rail. Special tests should be made to determine the maximum expansion space that is practicable, considering the riding of the track and the cost of maintenance. The labor cost involved is relatively small, as compared with the cost of material renewals. As the use of power appliances for the loading and unloading, laying and relaying is economical, and is becoming general, the principal difficulty in handling would be by the section gangs in replacing failed rails, which will be further reduced by the increasing use of motor cars by these gangs. As this represents such a small part of the whole maintenance, it will not be sufficient to limit the length of rail.

What the most desirable length is from a track standpoint, as suggested, must be determined by additional tests, but it probably is considerably longer than 33 ft. Most European roads use lengths not less than 39 ft., while many use 45 ft. and over, including lengths of 49 plus, 54 plus, 59 plus, 60 and some even 72 and 78 ft.

As to the transportation of rail, considering the present equipment over 33 ft. long of nine roads, Eastern and Western, only 10 per cent is long enough to handle rail over 40 ft. in length, while 60 per cent will carry rail 39 ft. long and 70 per cent is long enough for 36-ft. rail. Eastern roads transport rail largely in open top cars, while in the West stock cars are used extensively. With the present equipment, generally rail over 40 ft. long would have to be handled in two open top cars, at some additional cost for blocking.

As regards manufacture, some mills could probably furnish rail in lengths of 36 or 39 ft. without changes in their plants, while others might need some reconstruction of their hot-beds

and finishing facilities. There seems to be some additional difficulty in straightening very long rail, but this does not appear sufficient to appreciably affect such lengths as we may tentatively consider. On the other hand, there would be fewer rail to saw, drill, finish and handle for a given tonnage.

The sub-committee on Length of Rail adopted the following resolution:

"From tests of long rail on American roads and the general practice in Europe, it seems that a longer rail—probably not exceeding 45 ft.—would yield advantages from the standpoint of economy and better riding track, providing, however, there is no additional cost per ton."

The character of present equipment may render inadvisable the use of lengths greater than 36 ft. or 39 ft., but if transportation is practicable for lengths of 45 ft., it is the opinion of the sub-committee that a general trial use should be made for lengths above 33 ft. up to 45 ft.

Transverse Fissures.

Investigations have been made during the year to determine the cause of transverse fissures, if possible. Report No. 42 is a study of a rail, in service, in which transverse fissures developed. It shows the presence of a large number of small fissures, many of which were transverse fissures. Report No. 46 gives the result of a similar examination of new rails. The report shows the presence of interior fissures similar to those shown in rail in service by Report No. 42. The investigations have not progressed to a point where definite conclusions can be reached, but present indications point to these internal fissures—the result of rolling conditions—as a possible cause or at least a contributing cause of transverse fissures.

FUTURE WORK.

About the time when 100-lb. rail began to come into considerable use (1906) the railroads experienced great difficulty in getting proper rail material. Tonnage, and not quality, was the aim of the manufacturer. Agitation by the railroads for better material developed a criticism by the manufacturer of sections then in use—the manufacturer claiming that good material could not be produced unless the section was modified. The American Railway Association appointed a committee to revise the sections. This committee reported the A.R.A.-A and A.R.A.-B sections. The American Railway Association then asked the American Railway Engineering Association to investigate the use of these sections and report a single section for each weight of rail. Since that time the Rail committee has been making a study of the rail situation —both in the mill and in track. In making the investigations it has had the financial support of the American Railway Association, and it is gratifying to report that the manufacturers have given the committee increasing support and co-operation.

Coincident with the work of the committee, there has been a gradual improvement in the quality of the material in rails until now there is no longer, as in 1906, a hesitancy on the part of railroads to order 100-lb. rail because of their inability to get good material in that weight of rail. The committee, holding, as it did, a semi-official position (as representing the A.R.A., as well as the A.R.E.A.), has been able to influence, to a considerable degree, general opinion on the subject of the manufacture and use of rails, and this influence, it believes, has been a considerable factor in the better rail conditions now prevailing.

The A.R.A. will discontinue its financial support after April 1, 1915. Mr. Wickhorst has, however, been retained for one year after that date by the A.R.E.A. The committee feels that it is unfortunate that the financial aid of the A.R.A. has been withdrawn, and hopes that it will be only temporary. The A.R.E.A., of course, cannot employ Mr. Wickhorst permanently, but the standardization of practice in the manufacture of approximately $100,000,000 worth of rails per year would seem to warrant the small outlay incident to the prosecution of the work of the committee.

CONCLUSIONS.

The committee recommends the adoption of the following conclusions:

First (a), That the sections of rails recommended for weights of 100, 110 and 120 lb. per yd. be approved as standard and printed in the Manual.

(b) That the A.R.A.-A section be adopted as standard for 90-lb. rails.

(c) That for sections below 90 lbs. it is inadvisable to recommend any changes in the sections now in use.

(d) That the above conclusions be presented to the A.R.A. for adoption.

Second, that the specifications for material in Joint Bars be adopted and printed in the Manual.

Third, that the revisions of the specifications for Carbon Steel Rails be adopted and printed in the Manual.

J. A. Atwood (P. & L. E.), chairman; W. C. Cushing (P. L. W.), vice-chairman; E. B. Ashby (L. V.), A. S. Baldwin (I. C.), Chas. S. Churchill (N. & W.), J. B. Berry (Cons. Engr.), G. M. Davidson (C. & N. W.), Dr. P. H. Dudley (N. Y. C.), C. F. W. Felt (A. T. & S. F.), L. C. Fritch (C. N.), A. W. Gibbs (P. R. R.), A. H. Hogeland (G. N.), C. W. Huntington (M. & St. L.), John D. Isaacs (S. P.), Howard G. Kelley (G. T.), C. F. Loweth (C. M. & St. P.), H. B. MacFarland (A. T. & S. F.), R. Montfort (L. & N.), C. A. Morse (C. R. I. & P.), J. R. Onderdonk (B. & O.), J. P. Snow (Cons. Engr.), F. S. Stevens (P. & R.), A. W. Thompson (B. & O.), R. Trimble (P. L. W.), Geo. W. Vaughan (N. Y. C.), M. H. Wickhorst.

APPENDIX F.

INFLUENCE OF FINISHING TEMPERATURE ON OPEN-HEARTH RAILS.

An investigation was made concerning the influence of finishing temperature on the properties of open-hearth rails. The problem was divided into two parts—first, the influence on the rails of varying the initial temperature of the ingots as drawn from the pits; and, second, the influence on the rails of varying the finishing temperature by holding the bar toward the end of the rolling. A set of five ingots, all of one heat, was drawn from the soaking pits with varying temperatures and rolled into rail in the same manner, but, unfortunately, this part of the work was not successful, due to failure to obtain much range in the initial temperatures of the ingots. Another set of five ingots from the same heat was drawn from the soaking pits at about the same temperature for the several ingots, and rolled into rail in the same manner, except as to the length of time the bars were held toward the end before the finishing pass. The work was done at Gary, Ind., at the works of the Illinois Steel Company, who kindly furnished all the material and facilities for making this investigation. The rails were tested by means of drop tests, slow bending tests, tensile tests, transverse tests of the base, microphotographs and polishing of cross-sections.

The finishing temperatures of the rails were determined by means of a radiation pyrometer, showing the temperature of the bottom of the flange toward its edge. The comparisons between different temperatures, mentioned below, refer to differences in finishing temperatures obtained by holding the bar varying lengths of time before finishing. The finishing temperatures of the flange varied from 850 deg. C., with a shrinkage of 6.95 in., to 695 deg. C., with a shrinkage of 5.70 in. in a 33-ft. rail. The first bar was finished without holding between rolls, while the latter was held 115 seconds. The average decrease in shrinkage was .011 in. per second held.

The results in the drop, slow bending and transverse tests of the base were about the same for the different finishing temperatures, varied by holding the rail bar between rolls before final finishing. In the tensile tests the results were also about the same, except that the lower finishing temperatures showed a little greater elongation and reduction of area. The lower finishing temperatures also showed a somewhat finer grain structure.

APPENDIX G.

INTERNAL FISSURES IN NEW RAIL.

By M. H. WICKHORST, engineer of tests, Rail Committee.

In Report No. 42, "Study of a Rail with Internal Fissures," it was shown that a rail that had failed in service, due to a tranverse fissure, contained numerous small cracks or fissures in the head of the rail. These were most numerous in the lower part of the head and were mostly longitudinal, but some were transverse near the middle of the head. That work did not, however, show whether these cracks were developed in service or were contained in the original rail as made.

Report No. 45 described tests of rails finished at different temperatures, and cross-sections were selected from those rails for polishing by the improved method described in Report 42. The A and E rails were examined from 10 ingots of one heat and 4 sections were cut from each rail, making a total of 80 cross-sections. From each rail one section was cut from near each end and two from near the middle. The manufacture of these rails is described in Report 45. The rails were 100-lb A.R.A. type A section and were tested without straightening or gagging.

The preparation of the sections consisted of polishing with emery, etching or pickling with copper-ammonium chloride solution until the deposited copper could be wiped off easily and finally polished with tripoli to a point where any minute cracks or fissures showed plainly.

A few of the sections showed small cracks in the head or web, or both. All the cracks found were in the upper half of the A rails and none were found in any of the E rails. A

few of the cracks occurred in the web and had the appearance of being small slag enclosures, but most of them that occurred in the head had ragged sides and appeared to be tears or breaks in the steel.

This work indicates that cracks or ruptures may occur in new rails as made, but does not show at what stage of the manufacture these breaks occur, nor does it show the conditions that influence their occurrence. It is interesting to note that in this work they were found only in the A rails where some unevenness of composition would occur, and they occurred at different finishing temperatures, but the matter can be worked out only by considerable further experimental work.

APPENDIX I.

SPECIFICATIONS FOR HIGH-CARBON STEEL-JOINT BARS.

1. *Basis of Purchase.*—Inspectors representing the purchaser shall have free entry to the works of the manufacturer at all times while the contract is being executed, and shall have all reasonable facilities afforded them by the manufacturer to satisfy them that the joint bars have been made in accordance with the terms of the specifications.

2. All tests and inspection shall be made at the place of manufacture prior to loading, and shall be so conducted as not to interfere unnecessarily with the operation of the mill.

3. *Material.*—Material for joint bars shall be steel, made by the open-heart process.

4. *Chemical Properties.*—The chemical composition of each melt of steel from which joint bars are manufactured shall be within the following limits:

Phosphorus, per cent, maximum 0.04.

5. The manufacturer shall furnish the inspector a complete report of ladle analysis, showing carbon, manganese, phosphorus and sulphur content of each melt represented in the finished material. The purchaser may make a check analysis from the finished material; such analysis shall conform to the requirements in Section 4.

6. *Physical Properties and Tests.*—Joint bars shall conform to the following physical requirements:

(a) Tensile strength, lb. per sq. in., minimum, 85,000.
(b) Elongation, per cent in 2 in., minimum, 16.
(c) Cold bending without fracture on the outside of the bent portion through 90 deg. around an arc the diameter of which is three times the thickness of the test piece.

7. All test pieces shall be cut from finished bars.

(a) Standard ½ by 2-in. specimens, as adopted by the American Society for Testing Materials, shall be used for tension test.
(b) The bend test specimens shall be ½-in. square in section, or a rectangular bar ½-in. thick, with two parallel faces as rolled.

8. *General Requirements.*—The different sections of joint bars shall be rolled to dimensions specified in drawing furnished by the purchaser. No variation will be allowed in the dimensions affecting the fit and the fishing spaces of the rail. The maximum camber on either plant shall not exceed $\frac{1}{32}$-in. in 24 in.

9. The joint bars shall be sheared to the length prescribed by the purchaser and shall not vary therefrom by more than ⅛-in.

10. (a) All joint bars shall be punched, slotted and shaped at a temperature of not less than 800 deg. C. (1470 deg. F.).

(b) All bolt holes shall be punched in one operation, without bulging or distorting the section, and the bars shall be slotted for spikes, when required, in accordance with the drawings, the slotting being done in one operation; a variation of $\frac{1}{32}$-in. in the size and location of the holes will be allowed.

11. All joint bars must be finished smooth and true, without swelling over or under the bolt holes, and be free from flaws, seams, checks or fins, and the fishing angles must be fully maintained.

12. The manufacturer's identification symbol, kind of material, month and year rolled and number of design, shall be rolled in raised letters and figures on each bar. The number of the melt shall be plainly stenciled on each lot of joint bars.

13. *Inspection.*—The joint bars from each melt shall be piled separately until tested and inspected by the purchaser's inspector. One joint bar for tension test shall be selected by the inspector for each melt represented in finished bars, or by agreement specimen for tension test may be cut from the bar as rolled. One joint bar for bend test shall be selected by the inspector for each lot of 1,000 bars or less presented.

SPECIFICATIONS FOR HEAT-TREATED, OIL-QUENCHED, STEEL-JOINT BARS.

[Where specifications for heat-treated bars are the same as those for high-carbon bars given above they are not repeated.]

6. *Physical Properties and Tests.*—Joint bars shall conform to the following physical requirements:

(a) Tensile strength, lb. per sq. in., minimum, 100,000.
(b) Yield point, lb. per sq. in., minimum, 70,000.
(c) Elongation, per cent in 2 in., not less than $\frac{1{,}500{,}000}{\text{Ten. str.}}$ minimum, 12.
(d) Cold bending without fracture on the outside of the bent portion through 90 deg. around an arc, the diameter of which is one and one-half times the thickness of test piece.

8. *Heat Treatment.*—Joint bars shall be heated and quenched in an oil bath from a temperature of about 810 deg. C. (1490 deg. F.), and shall be kept in the oil bath until cold enough to be handled.

13. *General Requirements.*—The manufacturer's identification symbol, kind of material, month and year rolled, number of design, and the letters "HT," to signify heat-treated, shall be rolled in raised letters and figures on each bar.

14. *Inspection.*—The joint bars from each melt or heat treatment lot shall be piled separately until tested and inspected by the inspector. One joint bar for tension test shall be selected by the inspector for each melt or heat treatment lot represented in finished bars. One joint bar for bend test shall be selected by the inspector for each lot of 1,000 bars or less presented, or from each heat treatment lot.

Discussion on Rail.

Chairman Atwood presented the report offering the first conclusion for consideration. Paragraph (a) was adopted.

W. H. Courtenay (L. & N.): I favor the A. R. A. B. section in preference to the A. R. A. A section. It seems to me that A. R. A. B is better. It has a heavy base. I am told by some manufacturers that it is a better rolling mill proposition and ought to last longer.

(Paragraphs (b), (c) and (d) were then adopted.)

The investigations of the Rail Failures and the conclusions deducted therefrom were received as information as was the work on the special investigation of rails.

Chairman Atwood: The next subject specifications for material in rail joints. We have presented for your consideration specifications for high carbon steel joint bars and specifications for heat-treated oil-quenched, steel-joint bars, and these specifications we present for adoption by the convention.

(Both specifications were adopted as were the changes in the Manual and the second and third conclusions.)

Chairman Atwood: Dr. Dudley has made some investigation of transverse fissures which has not yet come generally before the Rail Committee. He has some points he would like to speak to you about.

Dr. P. H. Dudley: We find that in a very few rails that leave the hotbeds the transformations are not entirely complete, from hot molten metal to the finished product, during the recrudescence of the head and the base. That sometimes leaves a central core in the head that is less ductile than it is in another place, and that is injured more or less in the gagging. If there are any transformations that are not complete enough, the tendency of the gag is to uncap this slightly, leaving an impression there, and the wheels will develop a crack in that metal from which an interior transverse fissure will develop. That will be a high rail and gagged upon the head. The low rails will have the base turned up. The metal in the base must be shortened, and that in the head lengthened, the reverse of what it is in the high rail. If there are any incomplete transformations in the head of that rail, we may check that core. Those I found and could trace all of those with the straight edge where they had been gagged more or less, and I termed that the inter-granular neuclea. We had only a few specimens and I termed those non-ductile metal. It was difficult to find any metal that was separated, except the track. In the past few days we have had a great many specimens come in, in which we were able to show that the fissure was produced by the gagging as well.

One of the interesting developments of the inter-granular neuclea came in a few days ago in a Bessemer rail that was rolled in 1906. That was when they were making the rails as fast as they could in the Bessemer output, and we were using a two-in. nozzle for steaming the ingots. In this case we have the inter-granular neuclea shown too plainly in the head of the rail. An ideal etching of that same section shows there was an inclusion of cast iron cut out from the stool, and we have an outside envelope, a very ductile metal, and a higher carbon shown by the shading, but a central core that was checked in the gagging. This was a low rail, and gagged from the base. We have all the different tests

showing that it was very much harder; the base was tougher, and we have all the exterior envelope to show that that was a non-ductile metal. There is probability that considerable improvement can be made, even under the present methods of gagging. In gagging some of these high rails in the center, they are often hit four or five times in very short spaces. You straighten that long sweep in the rail by making a series of short curves and you gag it in ten, twelve, or fifteen places on top, and cut that long sweep into a series of short curves, and shorten it at each place it is gagged. If we had maximum by which we could take out that long sweep stretching over an inch, probably it would not be injured so much.

We have been making a number of observations by chalking rails and noticing the width of the mark. We chalk right across the rail. We notice the mark made by some passing wheel. Some of the wheels only removed about a quarter of an inch of the width of the mark, and another would take off a half inch at a different place. This is all under the passenger equipment. Now, the proposition is to carry the chamfering out pretty nearly to the rim of the wheel, so that as the train wheels run over the rails, we will produce a wear very uniformly over the head, as we did a decade ago. I have had trouble with these transverse fissures, and I wanted to see whether we had conclusive proof of the effect of the gagging of these rails, and they have all given proof that the coning of the wheels and the shape of the tread is not what it should be, and they want to return to a less coning, but have the tread extend out so that it will cover the full width of the head, for the tangents at least, so that it will be wider on all of the curves that happen to be laid a quarter of an inch or a half inch wide on the curves. We think the wheel pressure tenses are entirely too great, not only upon the wheel but on the rail heads for the best wear of the rail. Our rails from New York to Chicago cost for the two passenger tracks, about ten million dollars. In going over portions of the line the other day we saw that we were only wearing off inside the web. There were hardly any marks outside of that, so we expect to extend out the chamfer so as to distribute the wheel contacts, make those larger, and our wheel intensities over a larger area of circuits.

Mr. Trimble: What do you think of canting the rail in order to overcome the difficulties you have just mentioned?

Dr. Dudley: We have the rail canted in several places, but we don't think it meets the condition at all. We are going to extend the coning out, so that we can get it over the head, as we had it a few years ago.

C. E. Lindsay: Has Dr. Dudley found any fissures in the base of the rails due to gagging?

Dr. Dudley: No, sir; you break the rail. All the breaking effect comes from the locked-up strains in the gagging.

WATER SERVICE

The following subjects were assigned:

1. Complete report on the design and relative economy of track pans from an operating standpoint.
2. Report on deep wells and deep-well pumping and relative economy of this as compared with other sources of water supply.
3. Report on the use of compounds in locomotive boilers to counteract: (a) Foaming. (b) Scale formation.
4. Continue the study of recent developments in pumping machinery and various kinds of fuels used.

The committee has given careful consideration to the subject of the revision of the Manual, and presents for approval a number of important changes in the subject matter now embodied in the Manual under the heading of water service.

The committee reports progress on the subject of design and relative economy of track pans from an operating standpoint.

REVISION OF MANUAL.

EFFICIENCY OF WATER-SOFTENERS.

Substitute the following for paragraphs 1, 2 and 3:

Designing and Installation.

(1) Special study should be made relative to the economical value of treating the water, and the method best adapted to meet the conditions.

(2) The installation of softening plants should follow a systematic plan. Greater success is generally obtained by completing the installation on one division first, rather than installing plants at individual points of especially bad water.

(3) Before the treatment of a water supply is undertaken the effect of the treatment on the water should be determined by complete analysis of the water.

(4) The plant should be of adequate capacity. It is necessary to anticipate possible increases in the consumption of water at the station considered.

(5) The mechanical device for introducing reagents should be such as to insure as near as possible a quantity of reagent in direct proportion to the flow of the untreated water. It should be simple of construction and operation and not readily thrown out of adjustment.

Operation, Maintenance and Supervision.

(1) Adequate supervision is necessary to the successful operation of a softening plant. Such supervision should be exercised at least in part by a chemist, or an engineer having adequate knowledge of water treatment.

(2) Provision should be made for frequent analyses or hardness tests of both treated and raw water. This is necessary, principally as a check on the treatment, and also on account of changes in the condition of the raw water.

In order that the analyses shall be effective, they must be made under the supervision of a competent chemist.

(3) Where the consumption of water is in excess of the rated capacity of the plant the use of undertreated water should be avoided by the use of raw water to such an extent as to give ample time for the proper treatment of all water that passes through the softener. The exception to this rule

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Chairman Committee on Water Service.

is the case of water which is being treated for corrosive properties. Such water should not be used raw if it can be avoided.

(4) The solutions containing the reagent should be properly prepared.

(5) The reagents should be as near chemically pure as practicable.

FOAMING AND PRIMING.

Substitute the following:

Foaming from treated water is due to the presence of sodium salts, as a result of treatment for incrusting sulphates, together with such quantities of the alkali salts as may have been present in the raw water. This condition is aggravated and is to a large extent due to the presence of suspended matter in the water.

Concentration of foaming solids in locomotive boilers reaches the critical point at about 100 grains per gallon. Concentration above this point will result in foaming.

The grains per gallon of foaming matter in solution represent the minimum per cent of water which must be wasted from locomotive boilers to prevent concentration rising above the critical point.

The cost of each pound of foaming matter per 1,000 gal. of water is approximately equal to the cost of pumping, treating and heating 70 gal. of water to the temperature of the boiler water.

The most efficient results are obtained by systematic, frequent blowing-off of the boilers on the road, as well as at terminals, together with occasional complete blowing-down and washing of boilers.

There are, of course, conditions where the concentration of foaming solids is so great that the required amount of blowing-off would be both impracticable and uneconomical, and it is necessary to resort to anti-foaming compounds.

DEEP WELLS.

The committee finds, after careful consideration, that a comparison between deep wells and other sources of water supply as such would be of questionable value and recommends as a substitute, for another year's work, a comparison of the costs of pumping under various conditions and with various types of equipment.

The committee submitted a tabulated statement on deep wells and deep-well pumping, covering information from 34 railroads. This showed the character of the wells and gave cost data and other information concerning pumps and pumping for deep wells. The special features of this statement were the figures given for pumping by the air lift. The striking feature about this was that the quantity of air used per gallon of water pumped as given ranged from 1 cu. ft. to 48 cu. ft. The first is abnormally low, but it may be explainable by exceptional conditions, if such exist, not developed by the investigation. The second can only be explained on the assumption that a vast amount of air is being forced through a well whose capacity is limited, thereby resulting in great waste of air.

Some tests on the El Paso & Southwestern developed the fact that whereas the compressor had been running at a speed of 100 revolutions per minute, maintaining an air pressure of 100 lb. at the well and consuming 5 to 6 cu. ft. of air per gallon of water pumped, the same quantity of water was lifted by reducing the speed of the compressor to 50 revolutions and the air pressure at the well to 85 lb., resulting in a reduction of air consumed to 2.7 cu. ft. per gallon of water lifted.

The committee's investigations lead it to the conclusion that the air lift is in many respects a desirable system for many deep wells, especially those in which the water is delivered from fine sand, requiring for the exclusion of the latter screens so fine, in order to avoid trouble with the pump plungers, that the capacity of the well is limited. By the substitution of the air lift for such wells, it appears that coarse strainers may be used, thereby permitting pumping out the fine sand and the collection of coarser material around the strainers, resulting in largely increased yields from the wells.

THE USE OF COMPOUNDS IN LOCOMOTIVE BOILERS TO COUNTERACT FOAMING AND SCALING.

The practice of introducing substances into a boiler for the purpose of preventing or tending to prevent the formation of scale on the interior surface of a boiler is probably almost as old as the use of the steam engine. The substances having an anti-scale action may be divided into two general classes: first, those having a mechanical action; second, those having a chemical action.

Prevention of scale by mechanical means consists in dilution of the scale-forming solids as they are thrown out of solution so as to exhaust or destroy their cementing properties. The materials used for this purpose may be divided into two general classes: first, purely inert materials which become suspended in the boiling water in a finely divided state, and are then deposited with the scale-forming material as it is thrown out of solution; second, materials of an oily or gelatinous nature or which assume this state when suspended in water; such materials have a tendency to surround the scale-forming matter with a slimy coating and to cover the water surface of the boiler in a like manner.

To the first class belong clay, talc, moss, coloring matter, ground glass, bran, sand and sawdust. To the second belong algæ, potatoes, starches, linseed, sugar, molasses, gum, dextrines, stearine, peas, oils, graphite, animal carcasses and resin. Of these some could be placed in both classes of mechanical acting substances, while others have more or less of a chemical action in addition to the mechanical effect. To these classes may be added a third to cover the use of wire, brush, twigs, etc., which afford additional surface upon which the scale may form.

The use of inert materials in a boiler cannot be recommended. It is very doubtful whether inert inorganic materials, such as earths or ground glass or sand, do any good at all. The other materials, in order to be at all effective in the prevention of scale, must be introduced in great quantities, with the result that the tendency to foam is augmented. The quantity of matter carried to the bottom of the boiler is also greatly increased, thus requiring an increase in the amount of blowing-off and washing and increasing the chances of mud burning. With waters tending to foam, the suspended matter may be carried over into the valves and cylinders, resulting in excessive wear of the working parts.

Petroleum oils are very commonly used in boilers, both alone and as an ingredient of compounds. They serve the twofold purpose of loosening the scale already in the boiler, and preventing its subsequent formation. Many grades of oil are used, from kerosene to heavy crude oils. While there seems to be a wide disparity of opinion as to the use of oils in boilers, the fact remains that oils as anti-incrustants have many strong advocates.

The action of oils is to coat the entire interior surface of the boiler with a slippery veneer, to which the scale-forming solids cannot adhere. Even with the boiler surface covered with a coating of scale, the oils will tend to work into the cracks and with expansion and contraction gradually spread over the metal surface. Some oils also have a chemical action in that they combine with the calcium and magnesium salts to form insoluble soaps.

Several objections are raised to the use of oil, of which the most serious is the danger of burning and blistering due to the formation of a dense paste composed of a mixture of sediment and oil. In the absence of any fatty oils there does not appear to be much danger that this condition will be obtained unless they are used to excess or without proper care. Certain tests seem to indicate that oil has non-conducting properties far greater than those of scale, so that a film of oil of even inappreciable thickness may result in considerable fuel losses. Owing to the lack of sufficient verification, the extent of these losses can be only very roughly approximated at the present time. Oils sometimes give trouble through the passing into the cylinders of volatile constituents, which destroy the lubricating oils and rubber packing. When kerosene is used, open flames must be kept away from open manholes of empty boilers.

Oils are introduced into the boilers in most cases by some form of injector, such as the ordinary lubricator attached to the feed water pipe. A small pipe with a valve and immersed in a vessel of oil will serve the purpose. Another method is to throw the oil onto the surface of the water in the opened boiler, upon which it spreads out in a thin film to the sides of the boiler. Then as the boiler is emptied, this film of oil is carried down, covering the surface of all flues and the shell below the water line. Another method is to paint the interior with oil when empty.

The proportions of oil used seem to be governed more by the horsepower of the boiler than by the amount of incrustants in the water used. One advocate of kerosene recommends the use of one quart per day to 100 boiler horsepower.

Graphite.

Graphite is said to have properties similar to those of heavy oil and is introduced in the same manner. The flake or crystalline form of graphite is superior to the amorphous or powdered form for this purpose.

Prevention of scale formation through materials having chemical action comes about through reaction with the incrusting solids in the water to form new salts, which are either solubles to a high degree of concentration, or insolubles which have no incrusting properties, being precipitated as a sludge which is readily blown or washed out of the boiler.

Following is a list of chemical reagents which may be used to produce the results outlined above. Some are in common use, others are not, the considerations affecting a preference being cost, possible corrosive action, tendency to cause foaming, poisonous character, etc.:

Inorganic.—Sodium carbonate (Na_2CO_3), sodium silicate (Na_2SiO_3), tri-sodium phosphate (Na_3PO_4), sodium fluoride (NaF), caustic soda (NaOH), barium carbonate ($BaCO_3$), barium hydrate ($Ba(OH)_2$), barium chloride ($BaCl_2$), salammoniac (NH_4Cl), chromates, bichromates and oxalates.

Organic.—Tannic acid—tannates, other wood extracts, acetic acid, sugar, glycerin, oils and soaps.

Sodium Carbonate.

Sodium carbonate is the most common reagent used in boilers. It is found on the market in various forms under the names of soda crystals, sal soda, washing soda, scotch soda, concentrated crystal soda, sesqui carbonate of soda, crystal carbonate of soda, black ash, soda ash and pure alkali. The form commonly known as soda ash is the cheapest form of commercial sodium carbonate. Until recently it contained considerable quantities of impurities, but can now be obtained readily from 97 per cent to 99 per cent pure.

The principal disadvantage in the use of soda ash in boilers is the tendency of both sodium carbonate and sodium sulphate to cause foaming. The conditions are more severe when soda ash is used as a compound rather than as a reagent in a water-softener, because very little of the carbonates of lime or magnesia have been precipitated before entering the boiler and thus aggravate the foaming conditions by their presence in suspension.

Sodium carbonate is said by some to be much more conducive to foaming than sodium sulphate, consequently its

presence in a boiler ought to be prevented. By careful manipulation this may be accomplished fairly well in the water treated by a softening plant. On the other hand, with the use of sodium carbonate directly in locomotive boilers (tanks), an excess of the carbonate is almost sure to be obtained at some time during a run because of the impracticability of exact proportioning for the varying grades of water taken into the tank.

Soda ash is said to have a corrosive action on boilers, but from the consensus of opinion there appears to be small ground for this assertion. The use of large quantities of soda ash in boilers coated with scale will result in the rapid dissolving and loosening of the scale, thus uncovering leaks previously closed by the encrusted matter; and the leaky condition of the boiler thus produced has been incorrectly interpreted as an evidence of a corrosive action of the soda ash. In fact, it is the practice in the United States Navy to keep boiler waters alkaline by the use of soda ash as a measure for the prevention of corrosion.

Although this reagent has been repeatedly condemned by advocates of other chemicals, it remains the cheapest substance for the purpose. It is an ingredient of many proprietary compounds, including some for which all claims are based entirely on a mechanical action.

Sodium hydrate or caustic soda acts more quickly and powerfully than sodium carbonate. It is less desirable as a boiler compound than soda ash, because its caustic nature makes it dangerous to handle. There seems to be some difference of opinion as to possibility of corrosion from caustic soda.

Salammoniac.

Salammoniac, NH_4Cl, or ammonium chloride, and known also under the name of muriate of ammonia, is a by-product of the gas industry. It is not a desirable reagent for use in boilers owing to the possibility of liberating free hydrochloric acid with waters containing any amount of magnesium salts.

Barium Carbonate.

Barium carbonate is found in nature as witherite. It is also rapidly formed when baryta, hydrated or anhydrous, is exposed to the atmosphere and is also artificially made from heavy spar ($BaSO_4$). It is poisonous and only sparingly soluble in water.

Barium Chloride.

Barium chloride is prepared from witherite, the natural carbonate, or heavy spar, the natural sulphate. It is very soluble in water and very poisonous, but when used in the proportions required for water treatment is in no sense dangerous. The use of barium chloride with magnesium sulphate is not recommended on account of the corrosive tendency of the unstable magnesium chloride obtained in the reaction.

Barium Hydrate.

Barium hydrate, $Ba(OH)_2$, is an artificial product, not occurring in nature. It crystallizes from solution in crystals, $Ba(OH)_2 8H_2O$, which dissolve in water—20 parts at 15 deg. C. to 2 parts at boiling. The solution is caustic, but to a lesser degree that alkali caustic and decomposes on exposure to air with the formation of a film of barium carbonate.

Tannins are a rather common ingredient of boiler compounds.

The action of tannins in a boiler is complex and is still a matter of considerable conjecture. Ordinary tannins or tannic acid, whether free or combined with a metal when subjected to temperature and pressure conditions of a boiler, go through a series of reactions which result in the formation of one or more of a series of acids closely allied to tannic acid. Among these are gallic acid, pyrogallic acid, quercitanic acid, etc. These in turn act on the calcium and magnesium salts present in the water to form tannates, gallates, etc., of calcium and magnesium. Hydrates of these two salts may also be formed. Tannic acid or tannates when dissolved in hard or relatively pure water tend to cause corrosion, and must not be used in such waters unless made alkaline, as by the use of soda ash or other alkali salts.

British patent No. 23,618 of 1909 covers the use of barium salts with tannin. Barium tannate is formed by the action of tannin on the barium compound. The reaction in use in the boiler is as follows: Calcium carbonate plus calcium sulphate plus barium tannate equals barium sulphate plus barium carbonate plus calcium tannate. All these are non-incrusting compounds.

Sugars.

Sugar and substances containing sugar are used in boilers because they develop both a mechanical and a chemical effect. The mechanical action has been taken up previously. The chemical effect is due to a resulting increased solubility of lime and also to the formation of various sucrates of calcium and magnesium. A disadvantage of the use of sugar is the possibility of decomposition with storage where too warm, forming acetic acid, which, while it has a strong anti-scale effect, is sure to cause corrosion. Molasses of a grade which is by price available to use in boilers is liable to contain more or less sulphuric acid, a chemical not to be recommended for use in boilers.

Anti-Foaming Compounds.

Foaming of boilers results ordinarily from a concentration of alkali salts in the water, the exact degree of concentration to cause trouble depending on a number of other conditions, such as the amount of suspended matter in the water, rate of evaporation, etc. Unless the alkalinity of the water entering the boiler is too high, it is possible to control the concentration of the alkali salts by blowing-off. With some waters, however, notably in the states west of the Missouri river, this practice would result in the loss of excessive amounts of water and a large waste of fuel. Under such circumstances, the anti-foaming compound becomes a very important factor in boiler operation.

The action of materials tending to prevent foaming is physical, not chemical, and may be said, in general, to consist in a reduction of the surface tension of the water. Oils have this effect, petroleum oils and castor oil being commonly used. Tannic acids are also effective.

Very little has been written on the subject of anti-foaming agents and the use of other than patented or proprietary compounds seems to be very limited.

Extent of Use of Boiler Compounds.

Circular letters were sent out to mechanical officials on about 100 roads, inquiring as to the extent and manner of use of anti-scale and anti-foaming compounds. Fifty-nine replies were received, from which the following summary has been drawn as to the extent of use:

Roads reported	59
Roads using some form of boiler compounds	42
Roads using no boiler compound	16
Indefinite replies	1
Of those using compounds, extent of use is as follows:	
Use experimentally, or on less than 10 per cent of engines	12
Use on 10 per cent, but less than 50 per cent of engines.	13
Use on 50 per cent, but less than 90 per cent of engines.	7
Use on 90 per cent to 100 per cent of engines	10
Roads using some form of anti-scale compound	37
Roads using soda ash	19
Roads using caustic potash	2
Roads using proprietary compounds	26
Roads using a common chemical as well as proprietary compounds	8
Roads using some form of anti-foaming compound	20
Roads using proprietary compounds exclusively	18
Roads using both common chemical and proprietary compound	2
Roads using little or no anti-scaling compound	29
Of these 18 report reasons as follows:	
Good water	9
Use of water-softeners	5
No benefits	4

Boiler compounds are introduced in various ways, which may be enumerated as follows:

In the engine tank, the material being generally mixed in enough water to partially suspend it and then thrown into the tank at the time of filling.

Into the working boiler through the feed pipe. Oils, liquids and solids dissolved or suspended in water may be introduced in this way; generally by means of a syphon attached to the feed pipe outside of the injector. Special inspirators are sometimes used.

In the open boiler. Some forms of proprietary compounds are placed in the boiler in solid sticks or bricks through manholes or washout plug holes when boilers are being refilled after washing.

With a chemical-acting anti-scale agent, the best method of use, from a theoretical standpoint, is obviously one in which the chemical is added in exact proportion for the amount and quality of water as it is taken into the tank or boiler. To accomplish this it would be necessary to modify the treatment of water at each water station according to the content of incrusting solids. To this end, a compound for anti-scale use is sometimes given out to enginemen with instructions as to the amount to be used in engine tanks at the various water stations, but in general the practice has not been a success. In most cases such compounds as are placed in the tanks are applied only at terminals by the attendant

who fills the engine tanks, the amount being proportioned as well as possible to suit average condition of the water on the division.

Where a compound must be used to prevent foaming, the situation is somewhat difficult. In general, the material is introduced in proportion to the tendency to foam, as determined from experience and observation, rather than from a knowledge of the composition of the water.

For this reason the use of the anti-foaming compound is left much more to the judgment of the engineman. This applies both to compounds put into the tank and those introduced through the injector, though in the case of the former instructions are usually issued, giving the proportions to be used, but authorizing the engineman to use more than the specified amount if found necessary. Such instructions should always be accompanied with instructions for regular and thorough blowing-off.

The introduction of a compound through the injector is particularly advantageous where trouble with foaming is experienced, because this method permits of a quick increase or decrease in the proportion of compound in the water.

RECENT DEVELOPMENTS IN PUMPING MACHINERY.

The development of the internal combustion engine and the extension of electric power lines throughout the country, providing means for a reduction of the cost of operation of stationary engines, has resulted in the adoption of these agencies in numerous pumping plants.

The usefulness of any particular type of pumping plant is dependent upon its adaptation to the work required. The choice of the type for any particular location is determined primarily by the source of power available, source and character of water, quantity to be pumped and point of delivery. Having learned which kind of power is available, the further choice of the pump best suited for the purpose is dependent upon the economy of fuel, the efficiency of the pumping machinery and the degree of success in operation.

Centrifugal Pumps.

During the past 12 years great progress has been made in the theory and design of centrifugal pumps, so that now there has come into use the high pressure centrifugal pump capable of delivering large quantities of water under high heads, such as are used in certain mines where quantities of 1,000 gal. per min. against more than a 500-ft. head are delivered. The advantages of centrifugal pumps are the low cost, simplicity of parts, freedom from pulsation in operation, small floor space required, their adaptability to drive by belt or by direct connection to electric motor or steam turbines, the small amount of attention required and the small quantity of oil needed for lubrication. Centrifugal pumps are classified as high or low pressure pumps, the dividing line between the two types being about 30 to 50 ft. head of water delivered. They are also classed as horizontal or vertical pumps, according to the position of the shaft. Another distinction is made between two types of pumps, the Volute and the Turbine, the former without and the latter with guide vanes. The guide vanes were found to increase the efficiencies of high pressure pumps and are well suited to that class, though they also increase the efficiency of the low pressure type and are generally used with both.

The centrifugal pump has either an entrance or suction pipe, depending upon manner in which water is led into it. In a pump with entrance pipe, the pump is placed below the water level and is, therefore, always ready for service. Its inaccessibility when cleaning or repairs are needed is a serious disadvantage. The suction pipe is generally uesd, even though in most cases priming is necessary before it can be operated. The pump can, however, be thoroughly drained and made accessible.

There are six methods commonly used in driving centrifugal pumps: electric motor, gas engine, belt, steam turbine, water turbine and steam engine. By reason of their purely rotary motion, the electric motor and steam turbine are best suited. The efficiency obtainable is influenced by the speed at which pump is to be run, the head, the capacity and the characteristics desired. The following table gives the efficiency of centrifugal pumps as claimed by a leading manufacturer, covering those sizes applicable to railroad water stations:

Gals. per hr.	Gals. per min.	Size of pump.	Eff. of pump. Per cent.
8,000	133	2½	48
14,000	233	3	50
20,000	333	3½	55
30,000	500	4	60
40,000	667	5	65
50,000	833	6	68

Internal Combustion Engines.

The internal combustion engine has been developed industrially during the past 50 years. In railway water stations for many years gasoline had been used almost exclusively in this type of engine. During the past few years, however, the increased demand for gasoline has resulted in such an increase in price that gasoline engine plants no longer show a saving when compared with steam plants. It has, therefore, been necessary to find some other less expensive fuel to be used as a substitute and this emergency has been met by making use of oils of lower grades. Manufacturers have, therefore, developed a wide range of pumping units which utilize a number of these low grade oils for fuel, or may be operated by using the more expensive oils should occasion demand.

The oil engines in most common use in railway water stations are of two types:

(1) A two-cycle valveless type engine governed on the throttling principle, in which ignition is accomplished quite simply by means of a hollow hot ball.

(2) The four-cycle type, wherein there takes place four strokes of the piston or two revolutions of the crank. Ignition is effected by an electric spark or by contact with a hot surface, forcing the piston outward and by means of a connecting rod transmitting power to the crank shaft.

A number of gasoline engines have been converted into low grade oil-burning engines by the installation of appliances for heating the oil before it enters the cylinder. These attachments consist of generators, or mixing chambers, where the oil is heated by the exhaust of the engine, and are made in various sizes and types, both for throttling and hit-and-miss governors. Two methods of starting these engines are employed:

(1) By using gasoline for a quick start, running the engine on that fuel until sufficiently heated to permit changing to the heavier fuel oil on which it will subsequently run regularly.

(2) By installing a pocket or retort in the air inlet pipe where it can be heated by a torch. In this method approximately 15 minutes are required to start from cold and get the engine running regularly.

In connection with the use of either type of engine, an automatic stopping device can be installed. This will stop the engine when the tank or reservoir is full, at the same time opening the drain cocks to the water cylinder and pipe connections. These engines are also equipped with self-lubricating devices, and in some instances a reserve supply is maintained in case the other should clog. Attendance upon these engines is therefore necessary only in starting, but it must not be assumed that no other inspection of the machine is necessary.

KINDS OF OIL USED FOR FUEL.

These engines operate on gasoline, gas, naphtha, benzine, kerosene, crude oil and oils of lower grades, such as fuel oil, distillate, gas oil, solar oil, stove oil, engine distillate and Diesel oil.

Electric Motor-Driven Pumps.

The installation of electric power plants for the mechanical facilities of railroad terminals and the extension of electric power developments by private corporations and municipalities have made electric power so widely available that it is being used to a considerable extent in the operation of many railway water stations. Where current is available from the railroad powerhouse, it is apparent that it would be desirable to utilize it in the pumping station and thus avoid the installation of additional pumping facilities. In the case of private, corporate or municipal ownership of plants, it is often found that the owners are desirous of selling their power at an attractively low rate, providing that it is not consumed at a time when they are operating near their peak load. The operation of the water station may often be regulated so as to conform to these requirements and thus secure an economical power cost. In either situation it is many times possible to eliminate constant attendance and by use of an automatic controller for starting and stopping motors to cause the plant to be operated automatically, requiring attendance only for the inspection, repair and lubrication of machinery.

The electric motor speeds are so well adapted to the most desirable speeds for centrifugal pumps that the motor drive is most commonly employed. These pumps are designed for direct connection to either direct or alternating current motors. Where alternating current is used, consideration must be given to the available speeds in designing the pumps. With 25 cycles it is only possible to use speeds which correspond to synchronous speeds of 500, 750 and 1,500 revolutions per minute, except in large sizes, where lower speeds can occasionally be used. The centrifugal pump when direct con-

nected to a motor operates without any vibration, giving a decided advantage over the reciprocating pump in that heavy foundations are not required.

The initial cost of a centrifugal pump is less than that of a reciprocating pump, and at the same time the motor for the former will be cheaper than for the latter. Direct connected centrifugal pumps require high speed motors, whereas reciprocating pumps require slow speed motors.

Conditions Governing the Choice of Pumping Unit.

In small pumping plants, with a daily consumption of 50,000 gal. or less, it is usually possible to eliminate constant attendance. Under those conditions the internal combustion engine, using fuel oil, will prove most economical. Where the yield of water supply is sufficiently rapid, economy in operation will generally be secured by installing a pump of sufficient capacity to deliver the daily supply in a few hours. In the small pumping station, steam plants are uneconomical on account of requiring skillful attendants. The waste of fuel in firing up and in drawing or banking fire causes a further loss, tending to make such plants still less desirable. Where natural gas is available at 25 cents per 1,000 cu. ft., or less, it is an economical fuel. In localities where electric power is available at a low rate, as in connection with terminal machine shops or office building lighting, electric pumping plants are more economical than steam, gasoline or fuel oil engines unless the last named is secured at an exceptionally low rate.

If a rather constant delivery is required, resulting in a lower capacity for the pump, it will be found that the triplex reciprocating pump will prove to be more efficient than the centrifugal pump. In this case a slow speed motor direct connected to the pump will give the more satisfactory operation.

Table I, headed "Cost of fuel in various types of engines and pumps," giving the cost of fuel per unit of work done covering various types of engines, indicates the economy resulting from use of different fuels in the tests herein specified.

Table 1 - Cost of Fuel for Various Types of Pumps and Engines

Type		Fuel		B. H. P. Hour		Eff. H.P.	
Pump	Engine	Kind	Price	Fuel Used	Cost	No.	Cost 10 hr
Reciprocating	Steam (Slide Valve)	Bit.Coal	$2.00 per ton	14 lbs.	$0.0125	40	$5.15
"	Internal combustion	Gasoline	0.16 " gal	1/8 gal.	0.0200	50	4.00
" "	"	Ill. Gas	0.75 M cu.ft	12 cu.ft.	0.0090	50	1.90
" "	"	Nat. "	0.25 " "	8 " "	0.0020	50	.40
" "	"	Fuel Oil	0.06 per gal	1/8 gal.	0.0075	50	1.50
" "	Electric motor	Elec.	0.03 K.W.hr.	.746 K.W.	0.0224	50	4.48
Centrifugal	"	"	0.03 " "	.746 "	0.0224	50	4.48
"	Internal combustion	Gasoline	0.16 per gal	1/8 gal.	0.0200	50	4.00
"	"	Fuel Oil	0.06 " "	1/8 "	0.0075	50	1.50

Note: The last column, "Eff.H.P., Cost 10 hr." covers the work required to elevate 400 gal. per minute 100 ft., this being equivalent to a delivery of 240,000 gal. per day of 10 hours and is an average requirement condition of a railroad water station.

This table has been prepared from data secured from a series of tests of various pumping plants conducted by one of the largest railroads in the country, and from specific information relative to other tests conducted by other railroads, as well as by observations of tests by members of the Association and the committee.

A. F. Dorley (M. P.), chairman; J. L. Campbell (E. P. & S. W.), vice-chairman; J. T. Andrews (B. & O.), C. A. Ashbaugh (O. C. & S. F.), M. C. Blanchard (A. T. & S. F.), F. T. Beckett (C. R. I. & P.), C. C. Cook (B. & O.), R. H. Gaines (K. C. S.), W. S. Lacher (C. M. & St. P.), E. G. Lane (B. & O.), W. A. Parker (St. J. & G. I.), R. W. Willis (C. B. & Q.).

(The report was received and the committee excused.)

TRACK

DOUBLE-SLIP CROSSINGS, DOUBLE CROSSOVERS AND GUARD RAILS.

Your committee submitted drawings of typical layouts for Nos. 8, 11 and 16 double-slip crossings with movable points, to be operated by interlocking plant, together with drawings illustrating the spacing of ties for 16 ft. 6 in., 22 ft. and 33 ft. switch points for hand-throw and interlocking respectively.

The committee also submitted drawings of typical layouts for Nos. 8, 11 and 16 double crossovers for tracks 13-ft. centers.

Attention was called to the unsymmetrical arrangement, with the crotch frogs 6 ft. from the center of one track and 7 ft. from the center of the other.

The object of this arrangement is to properly guard the frog and crossing points, which is difficult and sometimes impossible with a symmetrical crossing when the distances between track centers are between 12 and 14 ft. With 12-ft. centers the upper half of the drawing would be used for both tracks, and with 14-ft. centers the lower half would be used, making symmetrical crossings. With centers under 12 ft. or between 13 and 14 ft., the upper half of the drawing would be used for one track and the distance from the crotch frog to the centers of the other track and the resulting leads would be varied to suit. With centers over 14 ft. or between 12 and 13 ft., the lower half would be used for one track and the layout

J. B. JENKINS,
Chairman Committee on Track.

for the other track varied to suit. Thus with any fractional distance between track centers, at least one of the two standards would be used.

The committee resubmitted for adoption the drawings of typical plans of Nos. 8, 11 and 16 double-slip crossings, changing the titles to read "Typical Layout for No. — Double-Slip Crossing."

The committee has made but little progress in the matter of guard rails.

RELATION BETWEEN WORN FLANGES AND WORN SWITCH POINTS

The committee has continued the study of the relations between worn flanges and worn switch points, with a view to correcting the causes and decreasing the number of derailments due to the combination of worn switch points and worn flanges on wheels, and has prepared a tentative rule for removing worn switch points, which will be used mainly as a basis for securing further information.

ECONOMICS OF TRACK LABOR.

The subjects assigned to the sub-committee for this season's work were:

(1) To continue the study of equating track values.

(2) To continue the study of extension of section foremen's duties.

One hundred and three requests were made for co-operation among the members of the Association in an effort to conduct a series of track tests for the purpose of arriving at relative values and track characteristics, and 17 railroads indicated their willingness to co-operate and have arranged to collect the necessary data. The tests will extend for one year, and the test sections have been selected with a view to

obtaining, as far as possible, all the various conditions entering into track maintenance.

With reference to subject No. 2, no further information is presented at this time, but we are watching the experiments which are being conducted by several railroads in connection with this subject and hope to present during the coming year some further light on the matter.

The sub-committee further recommends that the following subjects be taken up for the work next year:

(a) Economics of the use of motor cars.

(b) Investigation of the desirability of working a uniform track force throughout the season.

The sub-committee further recommends that the officers of the Association communicate again with the American Railway Association, strongly urging the adoption of December 31 as the end of the fiscal year, the reasons for which have been well put forward in the discussion of this matter at the 1914 convention.

CONTOUR OF CHILLED CAR WHEELS.

DESIGN OF MANGANESE FROGS AND CROSSINGS

The first subject was assigned to the sub-committee to consider jointly with a committee of the Master Car Builders' Association. No joint meeting was held with that committee, but the two committees have been in communication. The committee of the Master Car Builders' Association is compiling statistics of breakages of flanges in order to determine what part of the flange needs strengthening.

At a joint meeting of the sub-committee with the Standardization Committee of the Manganese Track Society and Manganese Steel Founders' Society and a committee of the Association of Manufacturers of Chilled Car Wheels, the questions of increased flanges on car wheels and increased flangeway and of standard design of manganese frogs and crossings were discussed. Until it is determined that the increased flanges are necessary, this committee does not feel called upon to take any action looking to an increase in flangeway, but will continue consideration of the subject in conjunction with a committee of the Master Car Builders' Association.

The committee offers the following tentative plans and specifications for manganese frogs and crossings:

Manganese Track Standards—Specifications.

Solid Frogs.

Referring to Drawing No. 1 of a solid frog, the minimum dimensions should be as follows:

a:—Not less than head of rail.
b:—1⅜ in.
c:—1 in.
d:—⅞ in., tapered to ¾ in.
e:—¾ in.
f:—½ in.
g:—¾ in.
h:—2¾ in.
j:—⅜ in.
l:—1¼ in.
m:—½ in.
n:—1 in.
o:—⅞ in., tapered to ¾ in.
p:—½ in.

q:—Place the actual point of frog at ⅝-in. spread of theoretical gage lines and chamfer the top to ½ in. wide, sloping the sides on a bevel to give a ¾-in. thickness of metal at ⅝ in. below the top; then join to the bottom of the groove with large fillet; the front of point to be sloped on an angle of about 45 deg. and curved or filleted to the bottom of the throat.

r:—Not less than ¼ in. and not more than ½ in. wider than the throatway.

s:—2¾ in.

Cross-ribs or tie-bars are recommended in the U section throughout the frog. They should be ¾ in. in thickness and not more than 18 in. apart.

"Section 4" to be not less than 1 in. thick at any point.

Rail-Bound Frogs.

Referring to drawing No. 2 of a rail-bound frog, the minimum dimensions should be as follows:

a:—2 in.
b:—1⅜ in.
c:—1 in.
d:—¾ in.
g:—¾ in.
i:—1⅜ in.
m:—½ in.

q:—Drawings No. 3 and 4. Place actual point of frog at ⅝ in. spread of theoretical gage lines and chamfer the top to ½ in. wide, sloping the sides on a bevel to give ¾ in. thickness of metal at ⅝ in. below top; then join to the bottom of the groove with a large fillet; the front of the point to be sloped on an angle of about 45 deg. and curved or filleted to the bottom of the throat.

r:—Not less than ¼ in. and not more than ½ in. wider than the throatway.

s:—Not less than 4¾ in., measured between gage lines at the ends of the rails.

t:—¾ in.
u:—¾ in.
v:—Not more than 2 in. nor less than 1¾ in.
w:—¾ in.
x:—⅜ in.

y:—With the head of the rail narrowed, the distance from the gage line of one heel rail to the back of the other heel rail shall not be less than 3½ in.

The manganese steel shall be carried beyond the waist (or bend in the wing rail) a sufficient distance to protect the rolled wing rail from the side blows of the wheel.

Minimum distance from gage line of one heel rail to back of other heel rail, at the top of the incline of the heel block, shall be 4½ in.; the length of slope, 6 in., with ½ in. drop, and the length of heel block, minimum, 15 in.

Cored holes to be not more than ⅛ in. greater diameter than bolt, except where a shearing strain comes on the bolt, and in such places the hole should be not more than $\frac{1}{16}$ in. larger than the bolt.

Bolts for all rails with a fishing section of over 3 in., measured on the vertical center line of the rail, should be 1¼ in. diameter; for rails with a less height of fishing section, down to and including 80-lb. rails, bolts should be 1⅛ in. diameter.

Sections for Solid Crossings.

Two sections are recommended for solid crossings, drawing No. 6 of a plain box or U-shape, with the webs flush with the outside edges of the top surface, and drawing No. 7, with an overhang of tread and guard to produce a fishing section for use at joints and where reinforcing bars are used.

The following dimensions are recommended:

Width of tread, 4 in.
Thickness under running surfaces, not less than 1⅜ in.
Thickness under groove, not less than 1 in.
Thickness of webs, not less than ⅞ in.
Thickness of flanges at out side edges, not less than ½ in.
Throat of groove to be 1⅞ in. deep and 1¾ in. wide at a point ⅝ in. below the tread surface.
Width of base flanges to be not less than 3½ in. each.
Width of guard for plain U section, 1⅛ in. minimum.
Width of guard for reinforced section, 1¾ in.
Overhang of head or guard for fishing section, 1⅛ in. minimum, but not less than the head of the adjoining rail.
Thickness of ribs or tie-bars on the plain U section, or the reinforced section where no metal surrounds the bolt, ¾ in., the vertical rib to extend to within ½ in. of the bottom of the section.

Cored holes to be of not more than ⅛ in. greater diameter than the bolts, except at the external joints, where larger or oblong holes can be used to compensate for shrinkage variations.

Bolts for all rails with a fishing section of over 3 in., measured on the vertical center line of rail, should be 1¼ in. diameter; for rails with a less height of fishing section, down to and including 80-lb. rails, bolts should be 1⅛ in. diameter.

Regarding the arms of crossings, it is recommended that easer extensions should be used in all cases, and the shaping of the arms to single web-rail section is not recommended. The run-off of the easer should be as long as possible, and a drop of ½ in. in a length of 12 in. is recommended where construction will permit. The general dimensions of the main sections, as far as applicable, are to be carried into the sections at the end joints and easer extensions. For internal joints of crossings, a miter joint across the tread, or a lap joint, is recommended.

REVISION OF MANUAL.

SUB-COMMITTEE NO. 5.

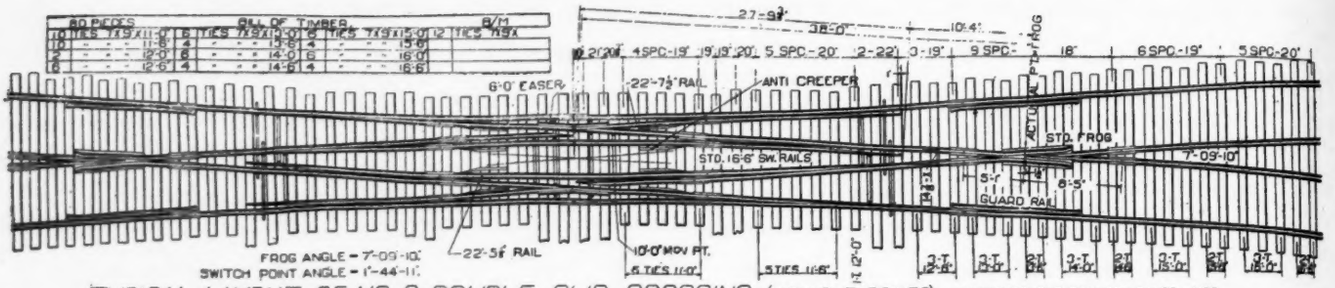
A number of minor changes in wording were recommended. The following additional definitions were proposed:

Connecting Track.—Two turnouts with the track between the frogs arranged to form a continuous passage between one track and another intersecting or oblique track or another remote parallel track.

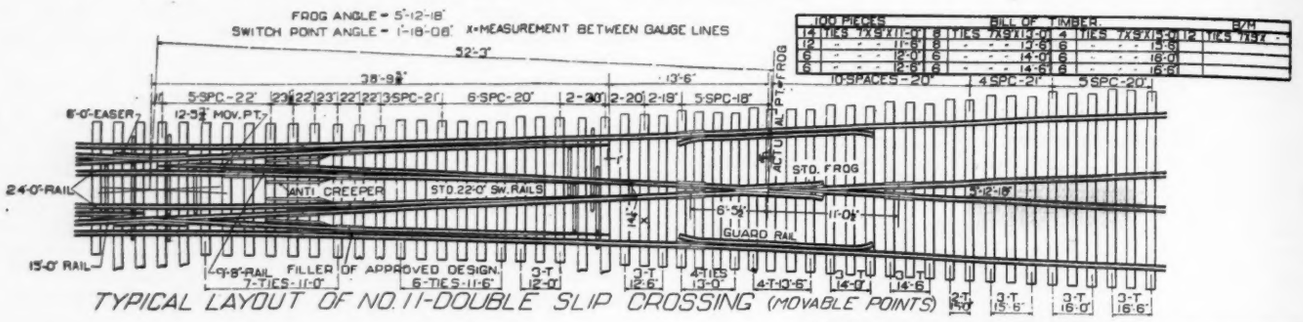
Crossover.—Two turnouts with the track between the frogs arranged to form a continuous passage between two nearby and generally parallel tracks.

Crossover, Double.—A combination of two crossovers in opposite directions which intersect between the parallel tracks.

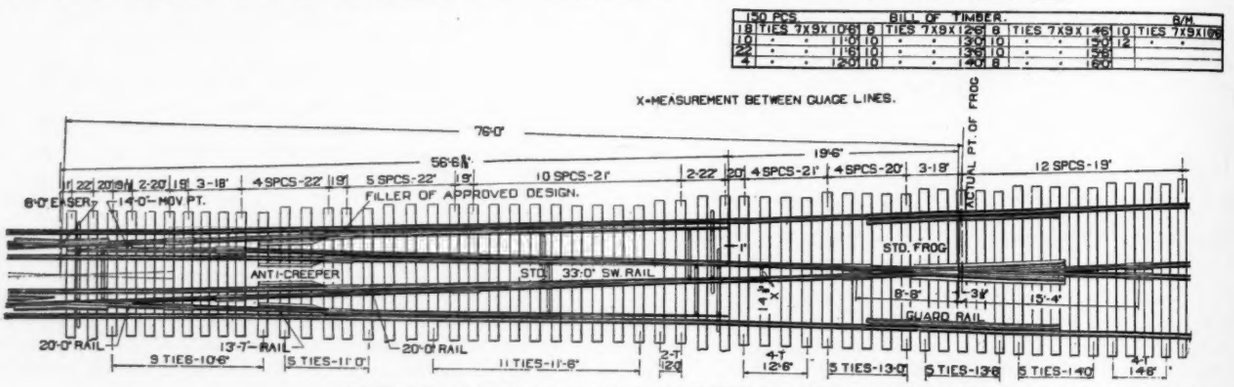
Frog.—A device used where two rails intersect to permit engines and trains on one rail to cross the other.



TYPICAL LAYOUT OF NO 8-DOUBLE SLIP CROSSING (MOVABLE POINTS) X=MEASUREMENT BETWEEN GAUGE LINES

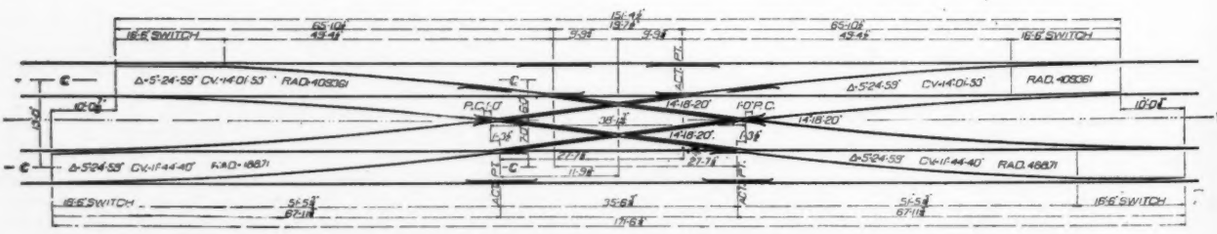


TYPICAL LAYOUT OF NO. 11-DOUBLE SLIP CROSSING (MOVABLE POINTS)

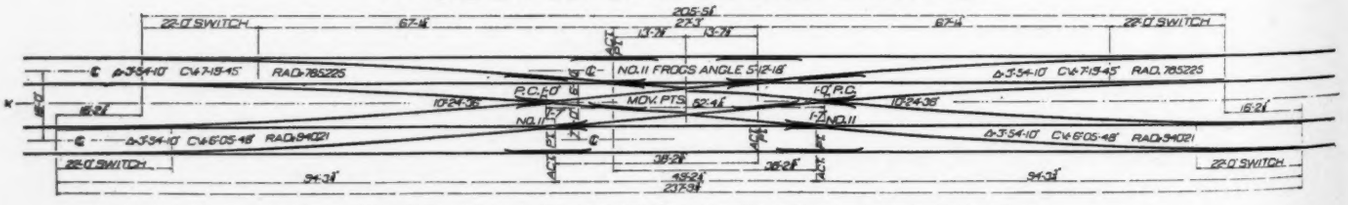


TYPICAL LAYOUT OF NO 16-DOUBLE SLIP CROSSING (MOVABLE POINTS)

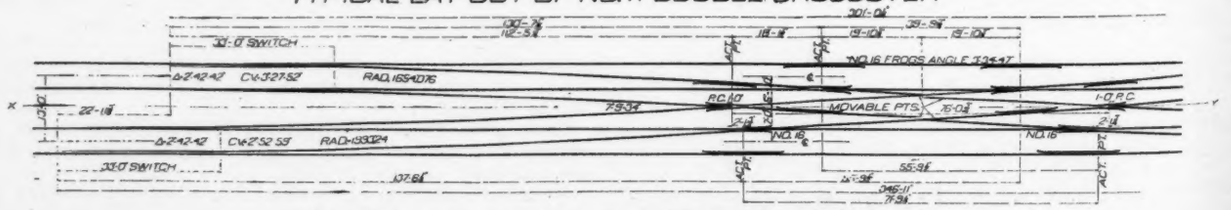
Double Slip Crossing Layouts Recommended for Adoption.



TYPICAL LAY-OUT OF NO. 8 DOUBLE CROSSOVER



TYPICAL LAY-OUT OF NO. 11 DOUBLE CROSSOVER



TYPICAL LAY-OUT OF NO. 16 DOUBLE CROSSOVER

Typical Layouts for Double Crossovers.

Gage (a tool).—A tool by which the gage of track is determined.

Lining Track.—Shifting the track laterally to conform to the established alinement.

Out of Face (referring to track work).—Work that proceeds completely and continuously over a given piece of track as distinguished from work at disconnected points only.

Scissors Crossover.—See "Crossover, Double."

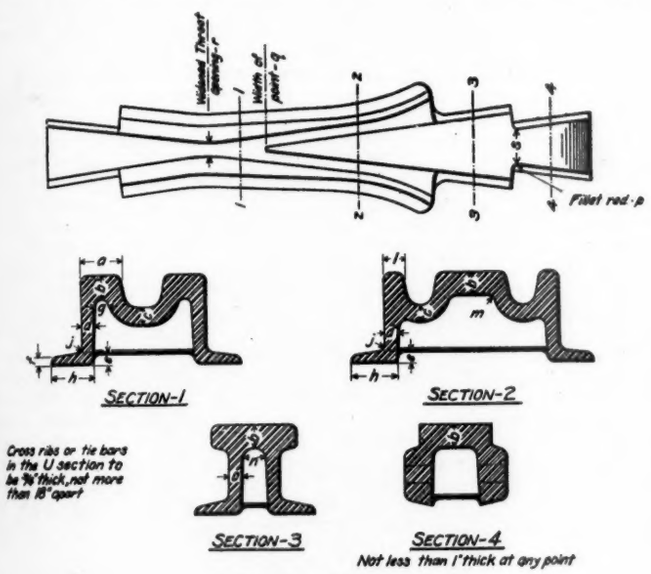
Slip Switch.—A combination of one or two pairs of turnouts and a crossing where each pair of turnouts has a common curved lead and stock rail, and the end frogs of the crossing serve for the turnouts.

Spiral (when used with respect to track).—A form of easement curve in which the change of degree of curve is uniform throughout its length.

Spiral, Ten-Chord.—An approximate spiral measured in ten equal chords and whose change of degree of curve is directly proportional to the length measured along the spiral by such chords.

Switch.—A device consisting of two movable rails, necessary connections and operating parts, designed to turn an engine or train from a track on which it is running.

Turnout.—A track device consisting of a switch and frog with connecting and operating parts and supporting ties by which engines and trains may be passed from one track to another. A turnout begins with the switch and ends with the switch ties, or with the frog where long ties are not used.


Widened Throat Opening-r
Width of point-q
Fillet rod-p
SECTION-1
SECTION-2
SECTION-3
SECTION-4
Cross ribs or tie bars in the U section to be ⅝" thick, not more than 18" apart
Not less than 1" thick at any point

Drawing No. 1.

Wye.—A principal track and two connecting tracks arranged like the letter "Y" with the top closed, by means of which engines or trains may be turned.

CONCLUSIONS.

Receiving as information:

(1) Drawings of typical layout of Nos. 8, 11 and 16 double-slip crossings, movable points to be operated by interlocking plant.

(2) Drawings of spacing of ties for switches to be operated by hand and by interlocking plant when No. 1 rod is used as lock rod.

(3) Drawings of typical layout of Nos. 8, 11 and 16 double cross-overs.

Receiving as a progress report:

The report on Economics of Track Labor.

For adoption:

(1) That it is very desirable that there be defined standards for the manufacture of manganese frogs and crossings.

(2) That drawings Nos. 1, 2, 3, 4, 5, 6 and 7 and specifications for solid frogs, rail-bound frogs and sections for solid crossings, Manganese Track Standards, appear to be satisfactory and that they be placed in general use as representing minimum sections, but they be not incorporated in the Manual for the present.

(3) That all frog, crossing or other track structures manufactured in accordance with these designs and specifications be stamped with the manufacturer's name and the initials "M. T. S.," signifying Manganese Track Specifications.

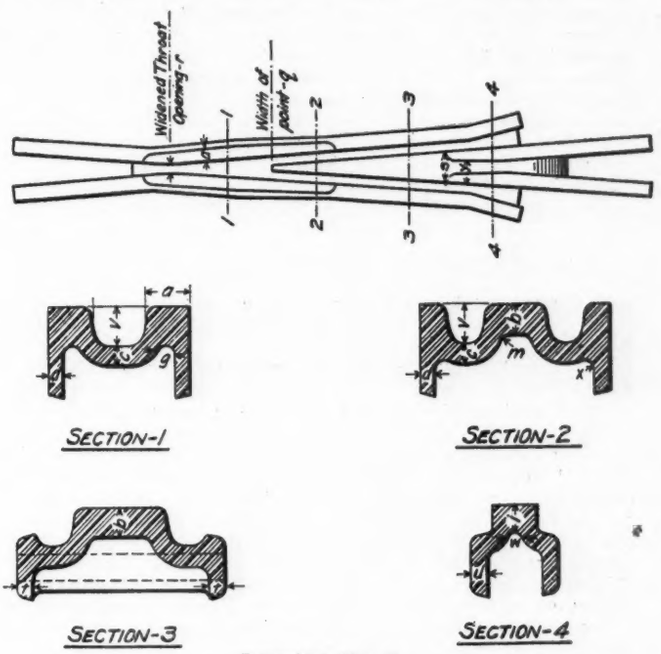
For adoption and publication in the Manual:

(1) Drawings of typical layout of Nos. 8, 11 and 16 double-slip crossings to be operated by hand as representing good practice for hand-thrown double-slip crossings.

(2) The recommended revision of the Manual.

The committee recommends for next year's work:

(1) Typical plans for guard rails, double-slip crossings to be operated by interlocking, typical layouts of Nos. 8, 11 and 16 double crossovers and specifications for crossings.



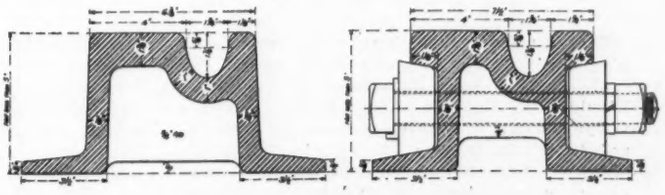
Drawing No. 2.

(2) Study the relation between worn flanges and worn switch points, with a view to correcting the causes and decreasing the number of derailments due to the combination of worn switch points and worn flanges on wheels.

(3) Continue the study of Economics of Track Labor.

(4) Confer with the Wheel committee of the Master Car Builders' Association on the question of increased flangeway to provide for wider flanges.

J. B. Jenkins (B. & O.), chairman; G. J. Ray (D. L. & W.), vice-chairman; Geo. H. Bremner (I. C. C.), H. M. Church (B. & O.), Garrett Davis (C. R. I. & P.), J. M. R. Fairbairn (C. P. R.), T. H. Hickey (M. C.), E. T. Howson (*Railway Age Gazette*), L. J. F. Hughes (C. R. I. & P.), T. T. Irving (G. T.), J. R. Leighty (M. P.), A. C. Mackenzie (C. P. R.), P. C. Newbegin (B. & A.), F. B. Oren (I. C.), R. M. Pearce (P. & L. E.), H. T. Porter (P. & L. E.), E. Raymond (A. T. & S. F.), W. G. Raymond (Univ. of Iowa), S. S. Roberts (Cons. Engr.), L. S. Rose (C. C. C. & St. L.), H. R. Safford, (G. T.), C. H. Stein (C. R. R. of N. J.), A. H. Stone (K. C. Term.), W. I. Trench (B. & O.).



Drawings No. 6 and No. 7.

Discussion on Track.

The report was presented by Chairman Jenkins. The conclusions submitted as information were accepted as such.

W. H. Elliott (N. Y. C.): I would like to suggest to the committee the checking up of the position of the head block tie with reference to the switch point of the interlocking switch.

C. E. Lindsay (N. Y. C.): On the same subject the committee has presented drawings of layouts, eight, eleven and sixteen, double slip crossings, to be received as information, those to be operated by interlocking. Down below they recommend for adoption and publication in the Manual the drawings of similar layouts for hand-thrown switches. In practice it is very desirable to put in an interlocking slip

switch and operate it by hand before the interlocking is complete.

Chairman Jenkins: The committee will take that under consideration.

(On motion the division of the report dealing with the economics of track labor was adopted.)

Mr. Safford: The sub-committee working on economics of track labor after considerable amount of study developed a plan whereby a great deal of valuable information can be collected, reflecting the distribution of labor and other expenses in all kinds of track conditions. We have distributed blanks calling for this information and desire the co-operation of the members in securing it.

The portion of the report dealing with the drawings of typical layout Nos. 8, 11 and 16, was referred back to the committee for further consideration in conference with the Railway Signal Association.

The other recommendations of the report were approved.

CONSERVATION OF NATURAL RESOURCES

The work assigned was as follows:

(1) Continue the study of tree planting and general reforestation.

(2) Continue the study of coal, fuel-oil and timber resources.

(3) Continue the study of iron and steel resources.

TREE PLANTING AND GENERAL REFORESTATION.

It is estimated that $75,000,000 is lost annually because the forest lands of the United States are unproductive, and that 40,000,000 acres of natural forest lands now denuded are incapable of being regenerated naturally. As we are using 40 cu. ft. of timber per capita annually, while the annual growth of the forests produces only 13 cu. ft. per capita, or only one-third of the timber consumed is replaced by growth, it was estimated at the Fifth Conservation Congress that we will experience a scarcity of timber in 33 years unless proper measures are taken to prevent it.

Work of reforestation is being conducted by the federal government, by several state commissions and institutions, by railroads and by private individuals.

The Forest Service of the United States Department of Agriculture is now reforesting about 20,000 acres per year in the western national forests.

The states which are reported as most extensively engaged in reforestation are New York, Pennsylvania, Massachusetts, Vermont, New Hampshire, Connecticut, Ohio, Michigan, Wisconsin and Minnesota. The New York State Conservation Commission furnished some 5,000,000 young trees in 1914, which were planted on about 5,000 acres, divided between the State Forest Preserve, state institutions and private owners.

The following railroads are known to have experimented with tree planting and reforestation: L. & N., D. & H., C. V., N. & W., B. & A., P. R. R., Pa. Lines West, A., T. & S. F., C. P., I. C., and N. Y. C.

The Louisville & Nashville reports over 1,500,000 trees planted in 1904, 1905 and 1906, mainly black locust, in Kentucky, and Catalpa Speciosa in other states from Illinois to Florida At Carney, Ala., 700 acres were planted in catalpa, though usually planted on small tracts of land at different points available, some being planted on the edge of the right-of-way, where wide. The main object was to encourage owners of vacant lands to follow this example and utilize their lands for tree planting, incidentally giving considerable timber for ties. Mr. Courtenay considers the experiment a failure, and thinks the company will probably never recover its expenditure. Eleven thousand catalpa trees were planted in northern Kentucky in 1904 and 1905, and an inspection during the summer of 1910 showed only 17.8 per cent in good condition, while 67.1 per cent were dead or missing, the remainder being rated as fair or bad; 74,600 locust trees were planted in the same territory in 1904-1905, and 65.6 per cent of these were reported dead or missing. Perhaps the most favorable growth of catalpa was planted in the depot park at La Grange, Ky., in 1903, where one of the best trees was cut March, 1913, and the maximum diameter of the trunk within the bark was found to be a little less than 6 in. During the first three or four years after planting a large amount of money was expended in cultivating them and in destroying worms which infest catalpa.

The Delaware & Hudson reports that 2,600 acres have been planted, beginning in 1907 and continued to date. The plantations vary in size from two to 650 acres. The lands planted have been mainly worn out agriculturally or denuded through cutting operations and subsequent fires. Very little broadcast sowing has been done, as it has been found that better results are obtained from setting out seedling and transplants. The poplar planted is expected to produce good pulp timber in 20 to 25 years, and the pine to be available for general use in 40 to 50 years. The land planted is not a producing territory and has a relatively low value. It is estimated that the net returns will ultimately be from 5 to 10 per cent annually. The company does not consider it wise to plant trees for railroad purposes on account of the time element and the possibility of using substitute materials in railroad construction.

The Cumberland Valley reports 200 acres planted in plots varying from 2 to 60 acres, the soil varying from a good quality of clay, underlaid with limestone, to the poorest slate and gravel. Plantings are on strips variously located, from joining the right-of-way to three miles distant from the tracks. Early in 1906, 10,000 yellow locusts were planted; in 1908, 13,600 red oak seedings; in 1909, 63,000 red oak seedings; in 1910, 4,000 yellow poplar (on deep, moist ground), 5,000 yellow locust, 38,000 red oak; in 1911, 49,000 red oak; in 1912, 68,000 red oak. These were one year old, 6 to 12 in. high. Young trees did better where grass and weeds were kept trimmed back; in some cases seedlings showed better in poor land than on richer soils, where grass and weeds grew rank. The plantings are designed to produce car lumber, switch timber and ties in 40 to 60 years, depending on the variety of tree and character of soil in which grown. The reforesting will also help to preserve the water supply.

The Norfolk & Western reports that in 1905 about 2,000 catalpa trees were planted at Ivor, Va., but a short trial showed them unsuitable, and the loblolly pine is the natural timber for the eastern section of the railway, so that the company has discontinued its experiment in reforestation.

The Boston & Albany Railroad reports a planting of 25 acres of catalpa some 20 years ago without success. Nothing further has been done in reforestation.

Incident to extensive changes of line and grade, the Pennsylvania Railroad acquired property in excess of actual right-of-way and station needs. Most of this land was unsuitable in size, shape and location for sale to farmers. Though more suitable to agriculture than silviculture, the Pennsylvania Railroad undertook to plant trees upon it to encourage farmers along its line to similarly use their waste areas. Many tree planters have profited by its advice and experience. The first planting was made in 1902, and black locust was used exclusively until 1906, on advice that it was the most desirable tree. Professional foresters were then engaged and the planting of locust discontinued. In the railway territory that tree is subject to attacks by two boring insects, which so infested the plantations that the trees grew much more slowly than expected, and have generally been made unfit for other than fence-post material. Since 1906 plantings have had no unusual troubles and promise to furnish timbers as large as cross-ties within 50 years. All the lands available had trees planted during 1913.

COAL, FUEL-OIL AND TIMBER RESOURCES.

Reports were issued in 1914 by the U. S. Geological Survey on the production in the year 1913 of coal, petroleum and natural gas; also fuel briquetting. Interesting points of information noted in the report on the production of coal are that there is good reason for the belief that the maximum annual production of anthracite coal is nearly attained, and that production will soon decline; no such condition is anticipated in the case of bituminous coal, but the supply known to be available is about 4,000 times the amount exhausted in 1913, so that a tremendous increase must be made in production in order to exhaust the supply within any moderate period. The anthracite supply may be estimated at about 88 times the amount exhausted in 1913.

The committee considers that it has a field of usefulness in collecting and presenting to the Association information as to progress in the use of methods to preserve and of more permanent materials to replace the perishable materials now in general use, such as untreated timber and bare steel. It is also felt that the employment of such methods and materials should be urged wherever they appear economical, and that careful consideration be given to the economics of such methods and materials. In this category falls the preservative treatment of timber ties, piles, telegraph poles, etc., the substitution of reinforced concrete for timber structures, poles, piles, etc., and for bare steel in bridge spans.

For next year's work the committee suggests that it be assigned the following subjects:

(1) Study of developments in methods of lumbering and forestry tending to prolong the timber supply.

(2) Collection of statistics on extent of use of treated timber and of permanent materials to replace untreated timber and bare steel.

(3) Study the conservation and utilization of water power for railway purposes.

(4) Continue the study of coal, fuel-oil, timber, iron and steel resources.

C. H. Fisk (Cons. Engr.), chairman; A. W. Carpenter (N. Y. C.), vice-chairman; R. H. Aishton (C. & N. W.), Moses Burpee (B. & A.), F. F. Busteed (C. P. R.), A. L. Davis (I. C.), W. A. Hammel, William McNab, (G. T.), A. L. Moorshead (Erie), Francis Lee Stuart (B. & O.), S. N. Williams, R. C. Young (L. S. & I.).

(The recommendations of the committee were approved.)

BUILDINGS

REVISION OF MANUAL.

Numerous changes in the Manual were recommended. The following are the more important:

Engine House Design.

Turntable.

(a) The turntable should be long enough to balance the engine when the tender is empty.

(b) A deck turntable is preferable to a through table.

(c) At important terminals, turntables are most economically operated by mechanical means. Where few and light engines are turned, hand operation may be desirable. Where electric power can be obtained at a reasonable cost, an electric tractor is the most efficient means for operating a turntable, the cost of power is cheaper, and it is superior in continuity of service and maintenance. The first cost is approximately the same as an air motor of equal power and size.

Power wires are brought to the table either overhead or underground. The overhead device has the advantage of

M. A. LONG,
Chairman Committee on Buildings.

accessibility for inspection and repair. Special care must be taken to properly protect the collector head from weather and gases and to support the collector rigidly (the framework supporting same should be fastened to the steel frame of the table and not to the ties, and must be securely braced); the wires should be large enough to keep them from breaking from sleet and should be supported to the framework supporting collector. Any play at the table multiplies at the collector head. Wires should be brought to pole, close to curb of turntable, keeping lines as far distant from nearest wall of roundhouse as possible, to minimize the danger of destruction by fire.

When the underground system is properly installed, its advantages are that all exposed, non-current carrying parts are permanently grounded, including the circular-track rail (the only part of the system to repair is collector head); and non-interference from the weather if the turntable pit is properly drained. The disadvantages are that the wire is not so easily repaired, and is much more difficult to install originally, as it must be properly protected from water and cannot be laid successfully in a fill or on ground where settlement or shifting takes place. Where turntable pit cannot be well drained, it cannot be used with success. It has the advantage of protecting the power to run the table in case of fire in the roundhouse, especially in one of a nearly complete circle.

Compressed air tractors are frequently used. Ordinarily the power costs much more than electricity and is not so reliable. At points having no power plant the locomotive to be turned furnishes the compressed air; in this case an auxiliary supply should be maintained by providing a small air tank secured to the turntable for operating it before or after the engine is placed.

(d) The deck on the turntable should be wide enough to provide a walk on each side and be protected with hand-rails.

Turntable Pit.

(a) The turntable pit should be well drained and preferably paved.

(b) The circle wall should be of concrete or brick, with a wood coping not less than 6 in. thick.

(c) The circle rail should preferably bear directly on a concrete base. The use of wood ties and tie-plates supported by masonry is desirable under some conditions.

(d) Easy access to the interior of a turntable for the oiling of bearings, paintings and inspection should be provided in the design of the turntable pit, unless ample provision is made in the turntable itself.

Door Openings.

The clear opening of entrance doors should not be less than 13 ft. in width and 16 ft. in height.

Doors.

Doors should be easily operated, fit snugly, be easily repaired and maintained, and should admit of the use of small doors.

Tracks.

(a) Lead tracks to the turntable should line up with tracks of the engine house where possible.

(b) Tracks should be on a level grade and should be provided with stop blocks.

(c) Special fastenings of the track rails at the circle wall and on the turntable are desirable to prevent movement of the rails, to give good bearing and to lessen the damage from derailed wheels.

Position of Locomotive.

In a circular house the locomotive should stand normally with the tender toward the turntable.

Length of House.

The length of stall along center line of track should be at least 15 ft. greater than the over-all length of the locomotive, to provide a walkway behind the tender, a trucking space in front of the pilot and a certain distance in which to stop the locomotive or to move it to bring the side rods or other parts into convenient positions.

Materials.

(a) The material used in the construction of the house should be non-corrosive, unless proper care be taken to prevent corrosion.

(b) The additional security against interruption to traffic from fire warrants serious consideration of the use of a fireproof roof, and dividing the engine house into units of approximately 10 stalls by the use of division walls built of fireproof material.

(c) When the roof is of reinforced concrete the columns and roofbeams should be of the same material.

(d) Reinforced concrete should be used for the walls only where special conditions reduce its cost below that of brick or plain concrete, and should not be used for that portion of the wall directly in line of track where engine is liable to run into it.

The specifications for roofings and the principle covering the design of inbound and outbound freight houses adopted last year were also presented for inclusion in the Manual.

A detailed set of specifications for a rest house for employes was presented.

METHOD OF HEATING FOR MEDIUM SIZED STATIONS.

Methods of Heating.—There are four general methods of heating medium-sized stations: stoves, hot air, steam and hot water. In small stations where there is but one waiting room, or two waiting rooms contiguous and adjoining the office on one side, a single stove can be used for heating the office and the waiting room or rooms. The stove is placed in the partition so that about half of it is in the waiting room, and the half with the fire door, ash door and damper in the office. The partition about the stove and for several feet from it to be of wire grillwork. Where the waiting room is not too large, such a plant is satisfactory and represents about the cheapest installation that will provide comfort in cold weather.

Where the waiting room is large or where two waiting rooms are separated by the office, another stove is necessary or a central heating plant required. Stoves of large size are more desirable than small ones, as they give greater economy in fuel consumption and require less attention. Stoves are hazardous

at best. In placing a stove, care should be taken to place it at a safe distance from wood walls or partitions and if the clearance is restricted, metal shields with air space should be provided to deflect the heat. On wood floors a metal mat or pan should be placed under the stove and project far enough in front of it to catch any coals that may fall out of the fire or ash doors should they be left open. Stove-pipes should not pass through the ceiling. If it is necessary for the pipe to go through a wood partition, it should be protected by a double metal ventilated thimble of fireproof construction around the pipe.

Central Heating Plant.—While accurate figures are not available, it is the opinion of the committee, obtained after careful observation, that in stations in cold climates where more than two rooms are to be heated and where an agent and operator are on duty 18 or more hours per day, that a central heating plant is more economical, cleaner, constitutes a less fire hazard and requires less attention than stoves. The plant may be of the hot water, steam or hot air type. There is little choice between hot water and steam; each has some advantages over the other. Hot air is doubtless the least desirable of the three.

Care should be taken in installation that the boiler, where hot water or steam is used, is of ample size. For stations in a northern climate, the boiler should be rated at about two-thirds its advertised capacity. A very liberal ratio of radiating surface to cubic contents of room heated should be used. Where supervision can be depended upon in care of the plant, it is sometimes desirable in hot water heating to use the closed system, so that the water may be raised to a higher temperature before boiling. Thermostats or damper regulators, properly designed for the kind of installation used, are recommended as fuel savers—they should be automatic in operation.

Hot Air Furnaces—Advantages and Disadvantages.—The advantages of heating by hot air furnace, as compared with stoves, are, in general, its greater convenience and cleanliness and greater economy of fuel and its less cost of installation as compared with heating by hot water or steam. Its main disadvantages are due to the fire risk when hot air furnaces are carelessly handled, and to its unsatisfactory results when a building is so large and has so many rooms that long air ducts are required. The principal objection to heating with hot air is that on windy days it is impossible to maintain heat in all parts of a large room.

Advantages of Hot Water.—The advantages of heating by hot water compared with heating by steam are mainly the less consumption of fuel, the less cost of maintenance of the plant, and the greater ease with which an even temperature is maintained; and in the spring and fall, when a small amount of heat is required, it can be readily secured by a hot water plant without overheating the building. Steam radiators will not begin to get warm until the fire in the heater is sufficient to give some steam pressure, whereas any increase in the temperature of the water in a hot water heater will at once cause the circulation of the water in the radiators.

Advantages of Steam.—The advantages of heating by steam compared with heating by hot water are that the original cost of the plant is at least 20 per cent less; that after steam is raised the building is more quickly heated than with hot water, and that there is less liability of damage to the radiators if, through neglect, the system is allowed to freeze.

Signal Towers, Etc.—For heating interlocking towers and similar buildings, when not larger than about 500 sq. ft., a hot air furnace made from an ordinary cast-iron coal stove enclosed in a well-made case of No. 22 or No. 24 galvanized iron is satisfactory. A space of six inches to a foot is left between the stove and the casing and a little more than a foot above the top of the stove where the case converges into a hood. Two hot air pipes, 10 to 12 in. in diameter, lead from the hood to the register above. This method of heating towers gives sufficient heat and keeps the floor warm, but has been found to be objectionable on account of the danger of fire caused by overheated stoves. A more satisfactory arrangement is to place a small stove on the second floor of the tower, or to use a low pressure steam heating system. The chimney should be well built of fireproof material and lined with fire clay or terra cotta flue lining. It should start from the ground and be built so that it will not interfere with the mechanism of the interlocking machine. It is usually found best to build the chimney outside instead of inside the tower. For towers or buildings larger than 500 sq. ft. hot water steam should be used.

METHODS OF LIGHTING MEDIUM-SIZED STATIONS.

Where current can be obtained at reasonable cost electricity should be used for lighting. In wiring stations, the rules and regulations recommended by the National Board of Fire Underwriters should be followed. Where electric current cannot be obtained, gas may be used. The principal hazard from gas lighting comes from the gas where an open jet is used. A mantle is preferable and recommended. The fixtures should be stationary. If the jets or mantles are less than three feet from a combustible ceiling overhead, a heat deflector suspended at least 4 in. below the ceiling should be provided. All gas connections to the building should have a shut-off valve in the service pipe at the entrance to building or at curb line. Where natural gas is used, a pressure regulator to guard against varying fluctuations in pressure should be provided.

In small towns where neither electricity nor gas can be had, the most available source of light is usually from kerosene oil. Well-made metal lamps only should be used. But a small quantity of oil should be kept in the building, and the supplies should be carefully safeguarded. A metal or metal-lined cabinet is desirable, with a metal receptacle for the oily waste.

There are several types of acetylene installations that are approved by the Underwriters. These provide a very effective lighting system, which requires very little labor and will provide a better light than oil at a cost about equal to gas lighting, where gas is selling for 80 cents per thousand feet. The fixtures for the acetylene installation are similar to a gas installation. There should be sufficient light, and it should be properly distributed so that there will be no dark corners, for where dark corners appear one can always find an insanitary condition existing.

On side platforms and island platforms, where no shelter sheds are provided, lamp posts should be provided about 80 to 100 ft. apart, depending on the kind of illumination used. Where shelter sheds are used, the lights should be placed preferably in the ceiling, one to each panel, or approximately 20-foot centers, using proportionately smaller light units.

SANITARY PROVISIONS FOR MEDIUM-SIZED STATIONS.

There are few items in railway operation more annoying than keeping the small and medium sized station neat and clean. To facilitate sanitary stations, the building should be designed to that end. All different planes should be connected by curves. All beads and angles that may collect dirt and protect disease germs should be avoided. In frame stations the wearing surface of the floor should be composition, laid on top of a single layer of T. & G. flooring. A better wearing surface would be to place a false floor about two inches below the top of the joists, beveling off the joists and laying approximately four inches of cinder concrete, and on this concrete lay vitrified tile. These tiles are made in various colors—the ones mostly recommended are dark red and gray. Where a solid fill can be had, vitrified brick, laid in pattern on (approximately) a 4-in. concrete base, provides a very satisfactory floor.

In frame stations with masonry founuations, the foundation walls may be brought up to the window sill, and when cement floors with hard plaster base and walls are used, the same end is effected at but little extra cost. All woodwork should be closely fitted and plain in detail. For waiting rooms and offices, sufficient ventilation may be had from windows and doors, but it is desirable to hang the window sash with balance weights, and, in many cases, to place transoms over the door. Sunlight is the greatest disinfectant, and the more of it the design of the building admits, the easier it will be to secure sanitary stations.

The designer should keep in mind that when his own work is finished the station agent's begins, and the easier he can make it for the janitor or agent to keep the place clean, the nearer will sanitary stations be approached. Care must be taken in installing water-closets in freezing climates to have all water pipes protected from frost. Means of draining the system are necessary. In general, when the work is installed in accordance with good practice in that particular latitude or locality, trouble from freezing will not be great if reasonable care is taken of the building. Where connection with water under pressure and sewers can be made, water-closets in the stations should be provided. They should be plain, durable and carefully installed by the best practice.

Where water under pressure is available, but connection with a sewer cannot be had, septic tanks may be used, and are recommended in small towns where drainage is practicable and at not too great a distance from the station. The capacity if a septic tank should be more than equal to the daily volume of sewage. The tank preferably should be covered, and in cold climates protected from freezing. The tank should be located where there is no liability of its overflow contaminating wells, springs or other drinking water, for while the overflow is clear and limpid, many deadly germs and baccilli are not eliminated. Septic tanks do not require a great deal of attention. The bacteria in the scum live upon the solids of the sewage, so that a large part of the solids pass off either in gas or in solution in the overflow. No disinfectant should be allowed to enter the sewage that is discharged into a septic tank, for the disinfectant will kill the bacteria that live upon and destroy the organic matter in the tank. The remaining solids must be washed or

flushed out of the tank occasionally. Suitable openings with valves are left in the tank for this purpose. In addition to septic tanks, there are other methods for disposing of toilet waste.

Several methods of chemical treatment of toilet waste are being exploited. One apparatus is of water-closet appearance in outward form, but the fecal matter, instead of going into a sewer, is caught in a tank of from 20 to 100 or so gallons in size. This tank contains, perhaps, 10 per cent of its capacity of water, to which has been added a strong disinfectant or solvent. After the tank has been partly or nearly filled, it is taken out and trucked to a convenient place and the contents emptied or buried. The seats and covers of these closets are made practically air-tight by use of specially made gaskets and a ventpipe leads out from the closet to a chimney or through the roof, so that but little odor escapes into the building.

Closet incinerators are also to be had. They have (the same as the chemical treatment) the advantage of destroying all germs, whether dangerous or not. They are more expensive to install and operate, and require more attention than the chemical closets. There is also some greater fire hazard where installed in the station building, but they have the advantage of totally destroying all refuse placed in them, and there is no objectionable residue left to be carried or carted away.

A last resort is the privy, and as there are perhaps more installations of this type than any other, they should receive attention, and be built to keep flies from making a breeding place out of them. Holes for ventilation should be covered with wire screen, and seats provided with lids. The excreta should be caught in an iron kettle, and this should be dosed with chemicals made for the purpose and then buried. They should be located at least 25 ft. from the station, preferably on the same side of the main track; and at combination stations they should preferably be located at the freight end.

M. A. Long (B. & O.), chairman; G. H. Gilbert (B. & O.), vice-chairman; G. W. Andrews (B. & O.), C. H. Fake (M. P. & B. T.), J. P. Canty (B. & M), E. A. Harrison (A. T. & S. F.), D. R. Collin (N. Y. C.), A. T. Hawk (C. R. I. & P.), W. H. Cookman (P. R. R.), H. A. Lloyd (Erie), C. G. Delo (C. G. W.), P. B. Roberts (G. T.), W. T. Dorrance (E. B. T.), W. S. Thompson (P. R. R.), Committee.

(The recommendations of the committee were approved.)

THE ANCIENT SNIPE AND HIS MODERN SNIPES

"No lik-a to start till seven a clock," said Tony Chirigos.
"Put on the kyar, 'tis half past six," quoth the Irish Section Boss.
"Dis big-a lever car no good," said Tony Chirigos.
"Ye gas-kyar Ginnies make me sick," quoth the Irish Section Boss.
"I'll have yez know, ye shrimps, that whilst yes worruk on Section 'Leven
Yez'll all be on the thrack tampin' ties at sthroke of seven;
Ye air not here for yer health, ye know; I'll see ye airn yer livin'
Whilst yer worruking fer Mulcahey on the Section."

"Dis-a line-a bar too heavy," cried little black Angelo.
"Let two of yez, thin, pull wan bar," they heard Mulcahey bellow.
"We gotta no tampa bars today," cried little black Angelo.
"Thin bend yer back and use thim picks," came back Mulcahey's bellow.
"Wid the tampin' bars, ye stand and talk; wid the picks, I'll make yez worruk,
Whilst I kape me eagle eye on yez, ye'll have no chance to shirk.
Any three of ye'll tamp less jints than wan good husky Turk
Who'ud be worruking fer Mulcahey on the Section."

"How long-a before we stoppa work?" old Dominick then cried.
"We'll put the hand-kyar on at six," the weary King Snipe sighed.
"Too late-a for our macarone," old Dominick then cried.
"Ye haven't done a day's worruk yet," the weary King Snipe sighed.
"A-chassin' ye and drivin' ye all day sure makes me weary,
I'd rather be a-diggin' peat on the bogs in County Kerry;
Sure I wisht I could send over there and just get wan good Jerry
To come worrukin' fer Mulcahey on the Section."

M. E. Carroll.

C. A. STEPHENS PROMOTED

C. A. Stephens, assistant engineer of the Texas City Transportation Company and the Texas City Terminal Company, has been appointed chief engineer, vice T. H. Kilpatrick, resigned.

SOME NEW CONTRACTS

The Flint River Railroad & Navigation Company has let a contract to Ricks & Co., Lilly, Ga., to build its line from Hawkinsville, Ga., to Albany, 80 miles. Ten miles of track has been laid.

The Philadelphia & Reading has let a contract to the Reading Contracting Company, Reading, Pa., for a 90-foot steel bridge north of Wagontown, Pa.

ANTI-PLUVIUS FOR NEW M. I. T. BUILDINGS

The G. Drouve Company of Bridgeport, Conn., has just received the contract for the installation of its Anti-Pluvius skylights and window-operating mechanism in the eleven new buildings for the new location of the Massachusetts Institute of Technology at Cambridge, Mass., for which the Stone & Webster Engineering Corporation has the construction contract. Skylights are generously used over practically all the buildings and in addition to the side lights will be the means of lighting the class and drafting rooms on the upper floors.

PROPOSED NEW PRODUCE TERMINAL FOR CHICAGO

The Atchison, Topeka & Santa Fe will petition the city council of Chicago in the near future for permission to close a few unimportant streets and build a fruit terminal on its property between Eighteenth and Twenty-second streets, Wentworth avenue and the Chicago river. The improvement as planned will include an auction house, a banana house, a cold storage plant and team tracks with a capacity of 1,000 cars per day. Some grading and leveling work will also have to be done and old tracks relocated and new ones laid. If the council passes this ordinance construction work will be begun at once. The estimated value of the land of the proposed site is $3,000,000.

ATTENDANCE AT THE COLISEUM

A large and enthusiastic crowd visited the Coliseum yesterday morning and from the interest shown and the opinions of the majority of the visitors that conditions in the buying field would soon approach a normal basis. One of the features of the convention this year is the improvements in the well-known appliances—the improvements in many instances showing a greater tendency toward simplicity with corresponding reduction in cost of manufacture. Naturally a large proportion of the visitors yesterday were track and signal men, but there were many operating and engineering officers. Many of the latter who are in town were doubtless at the meeting at the Congress Hotel. The exhibits of track tools and materials, and signal appliances, on account of the character of the visitors, were the busiest, and many of the exhibitors reported prospective purchases.

Annual Dinner of the Engineering Association

Abstracts of the Addresses Made at the Sixteenth Annual Banquet Last Night in the Gold Room of the Congress

The sixteenth annual dinner of the American Railway Engineering Association was given in the Gold room of the Congress hotel last night at seven o'clock. The banquet room was filled to capacity with members and guests who were entertained during the dinner by a musical program of orchestral and vocal selections. President W. B. Storey as toastmaster introduced the speakers, who were Chas. S. Gleed, president Missouri & Kansas Telephone Company; Sir George Foster, minister of trade and commerce in the cabinet of the Dominion of Canada; Frank L. Mulholland, President International Association of Rotary Clubs, and Benjamin Baum, chief engineer maintenance of way, Maumee Valley Railroad.

ABOUT THE HUMAN MIND

By CHARLES S. GLEED.

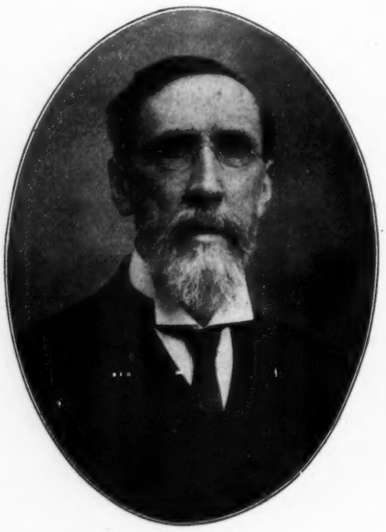
It is the habit of your lives to study foundations. In all the countless tasks that you undertake your first thought and your last relates to rocks, clays, soils, quicksands, water courses, pilings, fillings and footings—to whatsoever gives support to your structure. If you are neglectful of fundamental conditions in any respect it is probably, as with all high-class workers, within the realm of your own personal and professional welfare. That which means most to your personal and professional prosperity probably gets your last and your least attention. I cannot hope to tell you about this anything you do not already know. My only hope is that I may encourage you to give more attention than you hitherto have to a line of thought which I consider of paramount importance.

You have all acquired education from the books and from the teachers. You have all acquired the education which comes from practical undertaking—experience. You have all acquired the education which comes from watching others in their struggle for achievement. Armed with all this education, you naturally feel that you are fortified against the world, the flesh and the devil—that you know the way home. But there is at least one more river to cross. After all is said and done, after all your arduous preparation for usefulness, after you rightfully feel that you are masters of the situation, it still remains true that you are at the mercy of the human mind—the human mind as it actuates individuals and as it actuates masses—mobs, parties, communities, states, nations. The most skillful driver is never free from danger in that other drivers are stupid or careless. After taking every precaution which your own ingenuity can devise you are still at the mercy of those about you acting individually or in masses. It behooves you to know all you can of the weaknesses and treacheries of human nature.

In framing our opinions of the human mind as manifested by individuals or by masses our obligation seems imperative to judge by the standards of the most exalted, the most powerful and most clear-visioned specimens of the race. Christ and Socrates, Paul and Plato, Shakespeare and Lincoln—such are the men by whose teachings we must judge ourselves and our fellows. If this be true, I think we are forced at once to the conclusion that the human mind is almost as far below the standards as it is possible to be and still remain in the class. In short, the human mind, as we have it to deal with practically, is a superlative failure—a failure which would be a joke were it not a tragedy.

As we consider the men with whom we are most familiar, it is at least disheartening to comprehend how soon the best of them arrive at the outer limits of their intelligence. Select the masters about you in all lines of activity and see how little they know of what is knowable. Experiment with the ablest of your acquaintances and see how little dependable for wisdom are the best of them outside the narrow limits of their own specialties. The more an individual knows about his own specialty the less he seems to know about the specialties of others—about things in general. The more he knows about some things the less he knows about all other things. This seems an unjust law, but it is the law nevertheless. Time is of the essence of achievement. To fully master one line of knowledge requires more time than any man ever yet had. How, then, can one be expected to know much outside of his own field—his own tiny garden of truth? The man who knows the stars may not know the flowers in his wife's conservatory. The man with the legal decisions at his tongue's end may not know first base from third. The man who knows the pharmacopœia from cover to cover may not know "Louisiana Lou" from "Annie Laurie." The lady who knows Beethoven and Chopin may not know whether Wellington whipped Napoleon or Carranza. I knew a railroad president who solemnly assured me that any lameness could be cured, no matter what might be the cause or condition. I know a United States senator who is certain that he will never grow old, no matter how long he may live. I knew a college president who condemned railroad companies for issuing stocks and bonds because people were tempted to speculate in them. I asked him if he condemned farmers in the same way for raising grain and cotton. He said he had never heard of speculation in grain and cotton. Samuel Johnson's parents took him to the queen to be touched by her for his scrofulous disorder, and Johnson himself was so stupid as to despise the

CHARLES S. GLEED



SIR GEORGE FOSTER

FRANK L. MULHOLLAND

people of Scotland. I knew a president of the United States who thought all the people could be fooled all the time. The wonderful Wendell Phillips was a fiat money man and our popular secretary of state came within sixteen to one of being another. I think we all agree that Napoleon Bonaparte had superlative strength of mind, and yet, as he built the vast structure of his ambition, he forgot his foundations. His head was as big as his genius, but it got turned as easily as if it had belonged to some silly school girl. Millions of people woud have been happier if it had been turned two or three times around on his shoulders at a very early date. President Lincoln's favorite poem has the line, "Why should the spirit of mortal be proud?" There is no telling why, but there is no denying that it is. There is no disease more frequent among men of consequence than the disease known in Latin as caput elephantasis and in Anglo-Saxon as "big head." The big head is an indescribable vanity which prevents its victim from being considerate, sympathetic, amenable, approachable and teachable. It shuts all his doors for the ingress of knowledge and wisdom and for the egress of charity and sympathy. It involves an unreasonable estimate of one's own intelligence and ability and an absurd jealousy of the ability and intelligence of others. The time came when Napoleon could not tolerate information or advice. When his chiefs told him he would lose his army in Russia he plugged their mouths with the swab of his offended vanity. The deadly big-head had him. I knew a railroad official who spoke of his subordinates as being fools or they would not be his subordinates. My thoughts ran along the same line, though his meaning and mine were different. I knew another railroad official who declared his subordinates to be "a bully lot of fellows." The first official had the big-head; the second had the greatest of all power in an official, the power to do justice without malice and without envy. Most of the men with the big-head have more or less real merit on which to predicate their intemperate self-appreciation. How they can have strength of mind to be truly expert in certain directions and still consent to be victims of this peacockitis it is impossible to explain. If there is a man in this room who has not at some time suffered irreparable injury because his superior was really his inferior through the working of this malady then I miss my guess.

There is another mysterious mental disease sometimes called the pig head. It is like the disease which afflicts the balky horse—and his driver. The big head is often cured but the pig head is hopeless. Annihilation or abandonment are the only remedies. The law against murder stops us on one side and fear of cowardice on the other. All we can do in the presence of a real case of pig head is to watch and pray.

But unsatisfacory as the human mind appears in its individual aspects it is infinitely worse in its aggregations, its acts of co-operation.

A mass of human minds in action never comes up to the level of the best in the mass or even to the level of the average. The process of compromising differences seems to result in the best making far more surrender than the worst.

All history is an indictment and a conviction of the human mind in its aggregate acts. Whenever the people or a great body of the people have accomplished some great good it is always a good that should have been accomplished long before and in a better way. No man can credit the people with a single reform without admitting that it was long overdue when it came.

For the thirty or forty centuries of which we have knowledge history is one long, weary procession of horrors—horrors that never could have been but for the low mental condition of the peoples involved. A swift glance at the field in any direction shows this to be true. The persecution of the Christians by the Jews; the persecution of the Jews by everybody; the Goths and Vandals plunging southward like ravening wolves; Roman legions crashing through the jungles of the north with cruel feet and dripping blades; the long, horrid annals of Russian cruelty; the frightful story of the rise and fall of the Spanish Empire; the perpetual dance of death in Africa; the unspeakable degradations of India and China; the hells upon earth in France from Charlemagne to now; the melancholy story of the English-speaking people who have slaughtered and been slaughtered in every nook and corner of earth; worst of all, what is now happening in Europe and Mexico—all these go far to establish the identify of man and beast.

"But," says one, "this is the bad side or a bad side. Look at the work of religion in the world." The religious record of the world is indeed a bit more wholesome than the war record—though both are, much of the time in history, badly confused—but yet the record of formulated religious belief does not much more effectively sustain the claims of mankind to intellectual greatness than the war record.

In theory, at least, religion is not a matter of taste like the preference one may have for fruits and flowers or painting or music. A religious conviction must, nearly always, be right or it is wrong; correct or it is incorrect. If the billions of Buddhists are right the billions of Mohammedans are wrong. If the Jews are right, the Christians are wrong. If the adherents of the church of Rome are right, the Protestants are wrong. If the Calvanists are right, the Universalists are wrong. And so on. Through an endless list of comparisons one great mass is perpetually proving that itself or its antagonist is wrong. All may equally desire to be right, but if one realizes its desire and is right, the other, by the same token, fails of its desire and is wrong. Alas, how often is the latter verdict finally applied to both!

In politics, nearly all phases of politics, the people are almost always wrong. Lincoln is quoted as saying that you can't fool all the people all the time. This hardly seems true. All the people seem to get fooled all the time. Perhaps it is better to say that all the people fool themselves all the time. If this were not so all the conditions would certainly be different from what they now are. Through all history the people have tamely submitted to wrongs or have openly and affirmatively espoused them. In its last analysis African slavery in the United States was the work of the dear common people. The awful method of getting rid of it was the choice of the people. The people preferred the hellish eloquence of men like Toombs and Yancy to the wise counsels of men like Washington, Madison, Randolph, Lincoln, Lee and Stephens. Whenever the people do arrive at a right conclusion and a right determination, they are usually driven there by the hands of an angry God.

Almost every day one may read solemn newspaper demands that no court shall be permitted to declare unconstitutional any act of any state legislature or congress.

With all the million miles of written and spoken language about trusts as the word is used in modern political debate, no statesman and no party has ever yet described a trust any more precisely than scientific men have described the Snark and the Jabberwock.

There has been a copious flow of language and money to accomplish the physical valuation of railroads. Scarcely a man outside the railroad business tries to determine what that is. The physical valuation of a railroad is precisely the physical valuation of a farm. What is that? What would be the physical valuation of this hotel in the desert a hundred miles from any railroad? Masses of people all about us talk a lingo they do not understand and do not try to understand.

Every year the government of the United States spends a billion dollars for work and material which any well regulated railroad would get for half the sum.

Every year our people spend enough time and money on preliminary political processes which might well be dispensed with, to pay for putting their homes, their highways and all their public works in first-class order.

The people select their public servants because of importunity and because of promises impossible of fulfillment rather than because of ability, faithfulness and honesty. The man who begs most cravenly for any political place is the one who gets it. Who can imagine such a thing as the election of a man to office who would not go from door to door, man to man, begging votes? Ability, faithfulness and honesty are not demanded as necessary qualifications, though, thank God, we sometimes get them. No wonder that when a public servant does become fit he is usually kicked out to make room for a charlatan. Those who are able and fit are less likely to be retained than those who are tricksters and pretenders because the latter know how to appeal to the weaknesses of the people and are eager to do so.

I have referred to Lincoln's favorite poem and the line, "Why should the spirit of mortal be proud?" Lincoln knew that if he were as great and as good as his most ardent admirers believed him to be and in spite of all his limitless love for humanity the day would come when his fellow citizens would smite him—and it was so. If Booth and his coconspirators had spared his life no one doubts that in some twist of selfish, stupid passion his fellow citizens would have assaulted him as a blunderer or a villain.

The instinct of the assassin which makes men inclined to shoot every animal and slander every character lead them to use their ballots as they do their guns and their tongues.

If the letter carriers of the country were elected by the people the best men in the service could not long hold their jobs. Someone would lie about them and the people would gladly believe the lies. This popular affection for lies and liars makes it possible for a statistician like Lauck to put over the statement that there are $200,000,000 of water in Santa

Fe stock and that undue returns have been made on the investment in Chicago Great Western. It is the people's love of lies that causes most of the lying.

Any man is foolish to enter the service of the people unless his purpose is to rob the people or unless he goes in like a missionary to the cannibals content to carry on his work if need be inside the cannibals.

So in all other directions the people pursue humbug with flying feet and open arms. Barnum said so. Every other philosopher has said so. If all the members of this association were to be unanimous in advising a certain step in the engineering of the City of Chicago or any other city the advice would probably be overruled by the city government and by the people. On the other hand, the most ingenious member of the association could not construct a political, religious or social system so fantastic, so gross, so monstrous that great numbers of people would not at once become its ardent devotees. There is not an imaginable cult among men so unworthy as to be without its host of disciples.

If I were to select any set of men to be excused from this indictment it would be the members of the engineering profession. They are so in love with accuracy, correctness, fact, as to instinctively require to be "shown." Theologies have come and gone. Medical theories have endured for centuries to be upset in an hour. Legal practices have outlived the lives of nations only to be abandoned in a moment of reform. But the work of engineers, being rooted and grounded in accuracy, has never needed apology. Pyramids and aqueducts have remained and roads have endured. What has engineering not done for this day and generation? It has revolutionized transportation, dotted the land with magnificent bridges, harnessed the most unruly rivers to the uses of agriculture and the industries, tunneled the cities and the mountains, invaded the air, hunted out the lurking places of disease, opened up the mines, cut the great canals uniting lakes and rivers, oceans and oceans, and covered the land with the nerves of civilization so that Theodore Vail at Jekyl Island, President Wilson in Washington, Dr. Bell in New York and Thomas A. Watson in San Francisco could gossip together like so many friends at a single fireside. So, while my logic compels me to leave the engineers under the common charge of mental insufficiency, it is with the largest possible charitable reservation.

This line of thought may seem, at first, pessimistic and ill balanced. On the contrary it is intended to be optimistic and as good natured as a botanical analysis. It is a tearful yet entirely cheerful recognition of certain facts in the science of humanity and the history that man has made. One who says that the rattlesnake is, under certain circumstances, a vicious animal ought not to be called a pessimist. He is merely a reporter in natural history. No man is more unlovely and unloved than one who kicks against the pricks. The constitutional sorehead is disliked above all men. He is not a good sport. He sulks if he does not win. So this argument is intended to help you avoid the fate of the sulker and the sorehead. It is intended to fortify you, to arm you in advance, to give you the poise of the man who knows what to expect. Your own personal and professional prosperity depend on the thoughts and acts of others. They depend on what the people set for their standards generally. They depend on what the people permit to be done by those who directly furnish the money that supports your work. They depend on the individuals who dictate for you the course of events in detail. You are indeed at the mercy of the human mind with all its freezings and thawings, seepages and floods, slides and cleavages, quicksands and earthquakes. You need all the stoicisms of philosophy and all the consolations of religion.

THE MOBILIZATION OF HUMAN ENERGY

By SIR GEORGE FOSTER.

We are living in a day when the community of workers is being constantly and aggressively forwarded. And so we are living in an age of associations and conventions. If there is any one thing, looking at it from this point of view, which strikes one as differentiating this age from the ages long past it is that when we search through history we get very few records of associations and conventions of the workers and thinkers of the world. In this age we meet them every year and we look upon them almost every day.

All this means that we are making collections of knowledge in each one of the guilds and associations of workers and we are making it, not on the isolated plan, but on the plan of a community of interest. You work, each one of you in your own sphere and in your own locality, and then you come from every part of the United States and join in this great gathering every year and that knowledge that each one has gained and that experience which each one has had, and the results that he has worked out, are made common knowledge to you all and to the world as well.

It cannot be said that constructive engineering is the monopoly of any age or of any people. Go back as far as you please in history and there has been constructive work on more or less scientific principles, carried out by the engineer with skill and ability. You have beautiful palaces and temples; you have walled cities; you have works such as were developed in Egypt, the monoliths, the pyramids and the sphinxes; you have the splendid triumphs of Greece and of Rome in stone and marble, and there is hardly a country in the world where you cannot find the remains of great and wonderful engineering construction. There is just one characteristic which distinguishes between the constructive work of those ages and that of to-day, and that is that the work of those ages, it appears to me, had little respect for the utility, benefit and happiness of the masses. Those temples and palaces were built for the gods, for princes and for rulers. They lived in them during their lifetimes and they were buried in them after their deaths, or they were for the purposes of war, or they were for the commemoration of the wonderful things done by certain dynasties or commemoration of some great historical event, wrought out in those symbolical figures and signs that we find still remaining extant, but so far as having a direct tendency and purpose for the development of the world's resources, materially, mentally, intellectually and morally, they seemed to have little purpose.

To-day it is exactly opposite, and there is a very strong, distinctive characteristic between the work of to-day and then. Does not this show that the human mind has made some progress in the two or three thousand years that have intervened between that time and this?

This shows me that although the forces of the universe work slowly, they work surely, and to definite ends, and this community of knowledge, of resources, material, spiritual, mental and moral, this communizing of them, this spreading of them, this easy mobilization of them is what is doing the vast work of the world to-day. Then everything was fixed within narrow orbits. Thought, intellect, moral force, spiritual force, the fruits of nature and the products of industry, were all localized. To-day they are made as wide as the world, and through these benefits of constructive engineering and building skill the man who ten thousand miles away grows the fruits that we eat here in Chicago and in the cities of the West and of Europe, is enabled to transport the results of his labor from the far-distant sources of supply, and is benefited, and he benefits us. The world to-day is all working together. The world six thousand, four thousand, two thousand years ago worked in limited sections and to small purpose, compared with the work of the world to-day. So, this wonderful mobilization of the resources, the products and the forces of the world, taking them all together, is the distinguishing characteristic of to-day.

I take this as my philosopy: I can not well do my work if I simply keep my eyes on my own work and do not correlate it with two different things, correlate my individual work with the aim and purpose of that work, and then correlate my work along a certain line with the aim and purpose and work of workers of every other line. Neither do I think that railroad engineers, making a guild of themselves, bringing from all parts of the world their experiences, their results and their knowledge, and making it common and correlating it with that of all others, should stop there, because the railroad engineers, as a guild, are only a part of the working guilds of the world and other guilds in other lines must be correlated with you and you with them, and you must see with long, steady vision what all these are tending to, the uplift of humanity in the common work of the units and the associations of workers the wide world through.

So, I think the association of workers do their best when they correlate their work with the great purpose of all work. The works of to-day look toward the utility and the happiness and the comfort of the masses of people. Take those great works of irrigation which to-day in India are being carried out by the British government; take the works of irrigation in Egypt which add vast spaces of territory, convert them from the desert to fertility and give opportunity for work to those who work them, and opportunity for supply to those who need the supply. How different are those in their scope and their virtue from those great constructive works of the ancients that have no utility in them and confer no benefit upon the great masses of mankind.

We are more than carpenters and bridge builders; we are more than blacksmiths and machine builders; we are men. We are builders of character, builders of homes, builders of states, builders of nations, builders of empires; and when we rise to that thought and keep it with us, the smaller planes of work are ennobled and our own spirit grows and

our vision is made stronger and better as we show ourselves and feel ourselves niched in with every other man the wide world through, for the betterment of the race and the happiness of mankind.

BE GOOD FOR SOMETHING

By FRANK L. MULHOLLAND.

Do you know that every line of human activity is looking for the fellow who is good for something? In politics, in religion, in society, in business, in commerce; here and there and everywhere the cry goes out for more men who are good for something. Our fellow men do not care very much about what we have. But they are intensely interested in the question of what are we doing with it and how did we get it? Someone has said there is a readaptation of an old phrase, "The survival value"; not the survival value of those things we commonly call property, but the survival value of life, your survival value, my survival value. The worth of the individual today is measured by the question of whether somewhere, somehow, he has fathered some great thought, put into operation some splendid enterprise, stood for something for the common good that lives when he is gone.

I don't think that any man can be good for anything unless he has learned to smile. I have a wholesome respect for the influence of a smile. I used to live in a town in Michigan called Ausable. A fire visited that town a few years ago and burned up everything that could be burned. So we called together a lot of the old crowd, and proceeded to bury the town. About two years after that I thought I would stop off and see the old locality. I found to my surprise a station there, a bus running up town, a hotel, about 150 houses, a bridge across the Ausable river, and a new dock sticking out into Lake Erie. That night I picked up their little paper, and I saw a prominent exhibit of what I thought must have been the slogan that was adopted by the men who rebuilt my old town, and here is what it said: "Smile, you son-of-a-gun, smile!"

Now, the man who wants to be good for something and develop a survival value must, in my opinion, be optimistic. A friend of mine said that the real pessimist was the fellow, who, offered a choice of two evils, would grab them both.

I don't think a man can be good for anything or develop a survival value unless he is a booster. Somehow I don't believe that a man can be good for anything who is a knocker. I distinguish between a knocker and a kicker. It may be necessary to kick, but a knocker is a fellow who is born that way and who can't help it, and the only thing that you can do with that kind of an individual is to give him a hammer, turn him into a blacksmith's shop and let him work at his natural calling.

The place to develop a survival value is where you are, and in fact, the place to begin to clean up a community is in your own backyard. If you and I, and each of us, would just lay hold of a little sunshine, just get a good grip on optimism, see that our fellow men are worth while, this old world is a good place in which to dwell, we would make our respective communities a good place in which to live. I do want to challenge your attention, as I challenge my own, to the responsibilities that you and I owe to the community's interest. It is an old doctrine. It is a doctrine that as we give of ourselves we shall profit. The doctrine that the badge of service becomes the diadem of sovereignty, is the truest gospel that can be preached in my sermon, and it is a wonderful little doctrine. Here is the thought that I will close with: With optimism in our hearts, with the desire day after day to do something for the other fellow, we cast our bread upon the water and it will come to us another day.

RESULTS OF THE NICK-AND-BREAK TEST

Apropos of the nick-and-break tests on every ingot for open hearth steel rails about which much has been written in the last few years, it is interesting to cite some of the results obtained recently in testing according to the first specifications of this nature that have ever contained this requirement. It should be remembered that the fundamental feature of this specification is that if the regular drop tests as heretofore made on open hearth rail steel heats are successful a piece from the top end of each "A" rail from the heat shall be nicked and broken and, depending upon whether the fracture is free from interior defects, the remaining "A" rails of the ingot represented should be accepted or rejected. That is, if the fracture of the test piece is free from such defects or piping or evidence of segregation the "A" and remaining rails of the ingot are accepted. If the fracture shows an interior defect the "A" rail of that particular ingot is rejected and another test made on its bottom end to represent the "B" rail, etc. Thus the testing by nicking and breaking and close scrutiny of the fractures proceeds.

The difference between this specification and the A. R. E. A. specification is easily seen, for with the latter if any of the test pieces representing any heat show interior defects all the top or "A" rails of that heat are rejected and retests made on the "B" rails, etc.

Under the current Canadian Pacific specifications applied to rails now being rolled by the Algoma Steel Corporation the following chemical composition is specified:

Carbon—0.58 to 0.72 and a majority of the heats cast each day must have a carbon content of 0.63 or over.
Phosphorus—Not over 0.03.
Manganese—0.65 to 0.90.
Silicon—0.075 to 0.10.
Sulphur—Not over 0.055.

This in itself will be seen to possess difficult features, and further the drop test specifies that two pieces of three selected from the top ends of "A" rails of the first, middle and last full ingots shall stand a fall of a weight of 2,000 lbs. from a distance of 20 feet under the usual conditions for an 85-lb. rail section.

The first 161 heats cast and rolled gave two rejections under the drop test. On these there were 2,193 ingots cast, from which 154 "A" and "B" rails were rejected because of containing interior defects. Under a strict interpretation of the A. R. E. A. specifications 263 rails would have been rejected. There was, therefore, a saving to the mill of nearly 45 tons of rails, while the railroad obtained the benefit of having each ingot tested as a unit.

ATTENDANCE AT THE R. S. A. CONVENTION

In the issue of the Daily Railway Age Gazette of March 16, the registration of members of the Railway Signal Association was incorrectly stated as 163. The actual registration was 220 active, junior and associate members. At one of the sessions 260 attendants were counted so that it is certain that the actual attendance was considerably in excess of the registration.

OTHER MAINTENANCE OF WAY ASSOCIATIONS REPRESENTED AT THE CONVENTION

The presidents and secretaries of three of the other important maintenance of way associations have been in attendance at the convention the last two days: T. S. Stevens, president, and C. C. Rosenberg, secretary, of the Railway Signal Association; L. D. Hadwen, president, and C. A. Lichty, secretary, of the American Railway Bridge & Building Association, and J. H. Waterman, president, and F. J. Angier, secretary of the American Wood Preservers' Association. In addition, the Roadmasters' Association has a booth at the Coliseum and is holding forth there.

ATTENDANCE AT THE CONVENTION

Each year a good many members and guests at the A. R. E. A. convention are sufficiently impressed by the number of men in the Florentine room during the meetings or in the lobbies surrounding the meeting hall before or after a session, to express a belief that all previous records for attendance are being broken. As a matter of fact, the records show that up to the end of the second day of the convention two years ago 407 members had registered, that the corresponding figure last year was 475 and this year is 457. The attendance in the meetings and the interest taken, however, have been fully up to the standard of past years.

REGISTRATION—AMERICAN RAILWAY ENGINEERING ASSOCIATION

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Steward, H. M., Ch. Engr. M. of W., Boston Elevated Ry. Co., Boston, Mass.
Stradling, David W., Asst. Engr., C. I. & L. Ry., Chicago, Ill.
Strachen, G. M., A. T. & S. F. Ry., Chicago.
Stephens, K., Supt. Wichita Union Terminal Ry., Wichita, Kan.
Smith, E. Beach, Warren Chemical & Mfg. Co., New York City.
Trabue, R. P., Gen. Roadmaster, N. C. & St. L. Ry., Nashville, Tenn.
Van Brunt, John H., St. Joseph & Savannah Int. Co., St. Joseph.
Vickery, G. S., Supt. Frog & Switch Dept., Pennsylvania Steel Co., Steelton, Pa.
Wheeler, F. S., Div. Engr., Erie Railroad, Buffalo, N. Y.
White, R. B., Supt., C. H. & D. Ry., Indianapolis, Ind.
Winslow, C. G., Asst. Elec'l Engr., Michigan Central R. R., Detroit, Mich.
Wilson, John, Grand Trunk R. R., Hamilton, Ont.
Weber, T. J., Cons. Engr., United Light & Grand Rapids, Mich.
Wain, E. J., Grand Trunk Ry., Montreal, Que.
Williams, F. P., Div. Engr., B. & O. R. R., Connellsville, Pa.
Williams, G. P., Asst. Engr. M. of W., Long Island R. R., Jamaica, N. Y.
Young, J. B., Chemist, Philadelphia & Reading R. R., Reading, Pa.

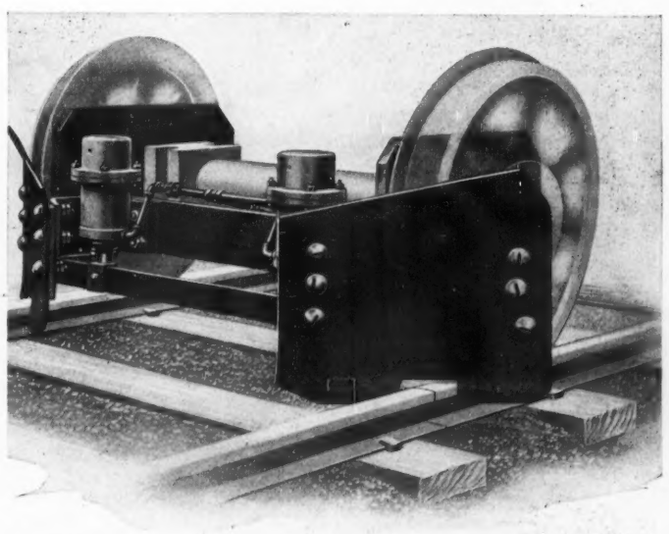
SCIENTIFIC RESEARCH IN THE UTILIZATION OF WOOD

The old method of judging lumber from personal experience has in a large measure given way to a selection on the basis of proven performance and adaptability. In order to help supply the scientific data necessary for engineers, contractors and architects to make such a selection the Southern Pine Association, formed in New Orleans last January, has made one of its primary purposes the carrying on of scientific research work. This association is composed of the manufacturers of yellow pine lumber in the southern states, its membership representing an annual production of approximately 5,000,000,000 ft. This research work will be under the supervisory charge of Dr. Hermann Von Schrenk of Von Schrenk & Kammerer, consulting timber engineers, St. Louis, Mo., and much of the work will be carried on in co-operation with the important national engineering and technical societies, including the American Railway Engineering Association, the American Wood Preservers' Association, the Master Car Builders' Association, the American Society for Testing Materials and the Western Society of Engineers.

The research work of this association will cover a wide field, taking up such scientific subjects as "Study of Fungi Attacking Yellow Pine Lumber," "Investigation of Failures of Yellow Pine Timber," "Investigation of Wood Fire Proofing Preparations," "Proper and Improper Uses for Yellow Pine," engineering subjects, such as "Plan for Various Types of Yellow Pine Construction," "Manual for Architects and Contractors," "Plans and Specifications for Ordinary Structures," chemical subjects, such as "Study of Utilization of Wood Waste," and various investigations of wood paving. The association invites engineers, contractors and others interested in yellow pine construction to consult it freely upon questions that may develop in connection with the utilization of this material.

THE RAY SELF-CONTAINED SNOW FLANGER

An important change has been made in the design of the lifting mechanism of the Ray snow flanger to make it automatic in action. In the former design the flanging blades were raised by the application of air to the operating cylinders and held in the raised position either by the continued



The Improved Ray Snow Flanger Applied to a Pony Truck.

air pressure or by holding rods. The flangers were lowered by releasing the air pressure, allowing them to drop under their own weight to a level ¾ in. to 1 in. above the top of the rail. In the improved design the flanger is forced to the lowered position by air pressure and is raised automatically by auxiliary springs within the operating cylinders as soon as the air pressure is released.

With the old equipment a break in the air line made it impossible to raise the flanger if it were lowered and allowed it to drop if it were in the raised position. Further, if the men in charge failed to hook up the flanger when not in use, it would drop to the lower position as the air pressure gradually decreased and, unknown to the operators, would remain in

that position until the engine struck a frog or crossing, damaging the blades and necessitating their removal for repairs. With the new type of cylinder the flanger is automatically raised if an air connection is broken, or if it is already in the raised position it becomes impossible for the engineer to lower the flanger for service until the break is repaired.

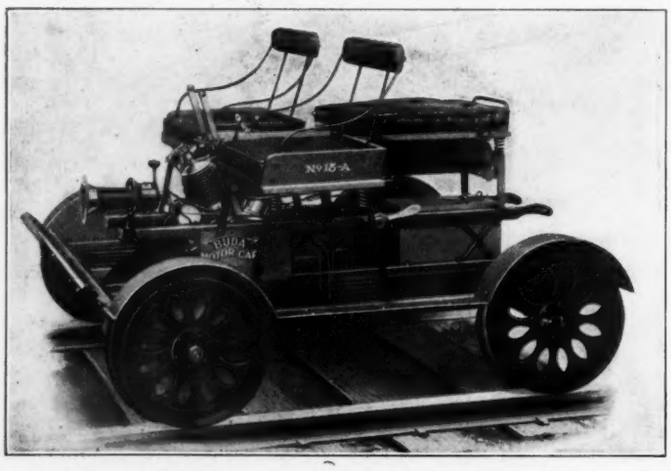
The complete weight of the moving parts of the improved flanger is about 500 lb. Each spring is designed to hold the flanger in the raised position without vibration and in addition to the spring a holding rod is furnished which can relieve the springs if desired. A forked piston rod in each cylinder straddles the cross-tie brace connecting the equalizers at the bottom, which in turn prevents the cross bar from dropping onto the rails when the flanger is lowered. The auxiliary springs are made from high grade spring steel, which is tested before assembling; the pistons are provided with a cast iron spring ring in addition to the cup leather packing and are designed to operate at 90 lb. air pressure.

The new type of lifting cylinder is interchangeable with the old and by furnishing a cross tie brace to join the two equalizers, the Priest snow flanger can also be transformed into the Ray improved type. This change eliminates all of the overhead lifting mechanism, such as the cylinder reach rod, axles, bearings, brackets, lifting rods, etc., and makes the flanger self-contained on the truck. The accompanying illustration shows the flanger applied to a standard pony truck. The assembled cross bar carrying the blade is of standard construction and can readily be changed from one engine to another, but it is generally necessary to make up new equalizer guide plates to suit the truck to which the flanger is to be attached. The lifting cylinders are arranged to exert the pressure directly over the center of gravity, thus reducing the wear on the equalizer guide slots to a minimum and causing the flanger to raise in a vertical line. These flangers have been successfully applied to all types of trucks on engine tenders, cabooses and freight cars.

This improved flanger was developed by the Railway Appliances Company and has recently been taken over by the Q. & C. Company, New York.

A THREE-PASSENGER INSPECTION CAR

In order to provide a more comfortable motor car for inspection purposes than those of the velocipede type and also to make it light enough to be operated without a train order the Buda Company, Chicago, has developed a new car



New Light Inspection Car for Three Passengers.

known as the No. 15-A. The frame is built up of square tubular steel with two seats facing forward and one lengthwise in the rear, all of these being mounted on coil springs and fitted with cushions. The engine is located between the two front seats bearing equally on the two sides of the car.

The engine is of the two-cylinder, four-cycle, air-cooled "V" type, developing seven horsepower. It is free running and is equipped with a muffler. The drive is of the multiple disc type, delivering power to the front axle through a roller chain and sprockets. A high tension Bosch magneto is provided, eliminating batteries. The engine is splash lubricated, the oil level being maintained by an automatic feed from the supply tank in the tool box. The timer, throttle, clutch, brake and muffler control levers are mounted over the engine in a position to allow them to be operated from any seat on the car. The car is braked by an external contracting band on the front axle.

The axles are 1½-in. in diameter, the wheels 17 in., with either a wood or a pressed steel center. The axle boxes are equipped with Hyatt roller bearings. The car weighs 530 lbs., so that it can be handled by one man if necessary. It has a rated speed of 5 to 35 miles per hour.

HYDRATED LIME FOR CONCRETE

Portland cement is dense and heavy, and when mixed with water and sand there is a tendency to segregate. This is especially true where unusually wet mixtures are used to facilitate placing the concrete.

As the durability of concrete depends upon the uniform distribution of cement, it follows that the separation of cement from the coarse aggregate would allow stone pockets and soft spots to form. It is at this point that hydrated lime exerts its physical influence and gives to the mass plasticity and uniformity, thus preventing the formation of such defects. It makes a fat, viscous mortar, which reduces to a minimum the possibility of segregation. This mortar adheres to each piece of the coarser aggregate and insures a uniform mixture of the aggregate.

In many large concrete operations it is customary to mix the concrete at a central point and elevate it, allowing it to run to place in the forms through chutes. To prevent sticking and clogging in the chutes it is quite usual to add more water to the mixture than usual to make it flow easily. This has the direct effect of causing segregation. The use of hydrated lime gives the mass sufficient plasticity to form a smooth-flowing, continuous stream, and the concrete falls into place, eliminating a large portion of the tamping and spading.

When moisture is allowed to penetrate concrete, it attacks the cement and causes this material to expand, and as the moisture dries out the cement naturally contracts. In order to prevent cracking from this cause the concrete should be a dense, impermeable mass. Hydrated lime increases the density of the concrete, as it has about 2½ times the volume of an equal weight of cement in its dry state. Being light and bulky, the lime fills up and closes all the minute voids in the concrete. This makes the mass so dense that it is rendered more nearly impermeable.

The consulting engineer on a large concrete dam in the West describes the use of hydrated lime as follows: "Fine and coarse crushed rock was stored in bins just above the mixing plant, from which 80 per cent of the concrete was poured down a spout or chute 400 ft. long to the dam site below. From numerous test results it was decided to use 10 per cent of hydrated lime, the mixture being 1:3:6. The concrete mixture without lime would not flow down the steel-lined chutes without mechanical aid, but by the addition of 10 per cent of hydrated lime, or approximately 40 lb. per yd., we literally transformed the physical appearance of the concrete. The concrete would leave the mixers, pass into the chutes and then onward without the slightest separation of the aggregate, and would arrive at the dam in a perfectly homogeneous mass, where it would flatten out to a level with but little shoveling and spading in the form. Without the use of hydrated lime in this work it was

actually demonstrated that it would have been impossible to secure satisfactory results without discarding the conveying of concrete in chutes and instituting a far more expensive method of handling the concrete."

COALING STATION WITH THREE STORAGE BINS

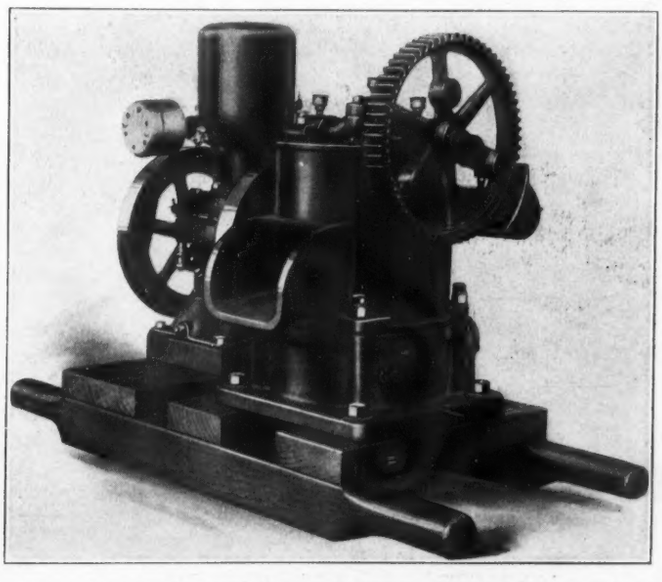
The Nashville, Chattanooga & St. Louis has recently completed a new locomotive coaling station at Hollow Rock Junction, Tenn., which is designed to handle separately three grades of coal coming from different mines and used

The N. C. & St. L. Coaling Station of Special Design at Hollow Rock Junction, Tenn.

by different classes of engines. The plant is of steel frame construction with steel storage tanks and an automatic balanced bucket elevating equipment. Two separate steel tanks are provided, one on either side of the elevating tower with capacities of 200 tons and 150 tons, respectively. The 150-ton tank is divided by a partition at right angles to the coaling tracks, separating it into bins of 75 tons capacity each. The coal which is dumped at the top of the elevating tower can be deflected to either of the storage tanks by a pivoted gate and if it goes to the divided tank it may be deflected to either side of the partition by another gate, both of which are controlled by a cable from the ground. The plant is arranged to deliver coal on two tracks, the 200-ton bin and one of the 75-ton bins serving one track and the other 75-ton bin the other track. Crossovers are conveniently located for placing locomotives on either side of the plant as desired. The entire plant was built on piling driven about 22 ft. to solid rock. The reinforced concrete hopper under the receiving track which is located between the coaling tracks was carried to solid rock. The steel frame structure is supported on concrete pedestals resting on piles. The elevating outfit has a capacity of 50 tons per hour, and is operated by a 16-hp. gasoline engine. As there was some question in the minds of the engineers as to whether Hollow Rock Junction would continue to be the best location for this plant, the design was worked out with great care in order to make as much of the equipment as possible available for use in single tank stations, if it should become advisable to change the method of operation or to move the plant to another location. The steel details are arranged to allow either tank to be used with the elevating tower if such a change is made so that by providing another tower and supporting frame, two separate plants could be built.

NEW POWER DIAPHRAGM PUMP FOR GAS ENGINE DRIVE

A convenient portable power pumping outfit has been placed on the market recently by the Goulds Manufacturing Company, Seneca Falls, N. Y., consisting of a diaphragm pump similar in design to those previously manufactured by this company, which is arranged for direct connection to any engine either by gearing or by belting. The old pump could not be driven by a gasoline engine except by the use of a pump jack made especially for that purpose. The new outfit



An Easily Portable Diaphragm Pump Direct Connected to Gasoline Engine.

is carefully designed to make it as compact as possible so that it is easily portable.

The pump itself consists of two valves and a strong rubber diaphragm which creates suction by an up and down motion. It is fitted for side suction and has a rubber suction valve resting on an inclined seat, thus offering slight resistance to the passage of a liquid. The metal discharge valve seats on the diaphragm and is easily removable. The waterways are large and are designed to handle a large amount of liquid easily. A 1-h. p. engine is sufficient to drive this pump. The stroke is 2¼ in., a 3-in. suction pipe is used, and the displacement per revolution is 0.8 gal. It is recommended that the pumps be run at 35 to 50 revolutions per minute. The weight of the outfit exclusive of pulley or auxiliary gear-

ing is 210 lbs. The new pump is geared 5 to 1 and when furnished to belt drive is fitted with a single tight pulley 12 in. in diameter with a 3-in. face. When furnished for direct connection to the engine a second gear reduction is furnished. Any one of the eight sets of gears can be furnished to secure an over-all gear ratio varying between 6.1 to 1, and 16.6 to 1, so that the pump can be direct connected to practically any engine. The base of the pump is square and is provided with extra large holes for bolting it securely to the mounting.

RACK AND PINION ELECTRO-PNEUMATIC SWITCH AND LOCK MOVEMENT

The rack and pinion electro-pneumatic switch and lock movement is a new design developed by the Union Switch & Signal Company, Swissvale, Pa., employing two single-acting cylinders instead of one double-acting cylinder. Connected to the pistons are parallel racks which engage a pinion located between them. The shaft of the pinion terminates in a crank which is connected to the switch. The crank moves through an angle of about 220 deg., traveling 20 deg. past dead center at each end of the throw. This arrangement accomplishes a locking of the switch points in their final positions in addition to the locking of the lock rod by the ends of the racks, one of which bolt locks the adjustable lock rod in the normal, and one in the reverse positions of the switch. The switch movement has the advantage of a greater efficiency than the former type and will operate on much lower air pressure. There is also the advantage that it occupies but two ties and requires no removable covers. The circuit controller used with this switch movement is designed

"Twin-Cylinder" Switch and Lock Movement.

to give either direct battery or polarized indication. The model 13 switch valve is used which, in actual practice, is set upon a separate foundation and connected to the switch movement by armored hose.

AN IMPROVED BONDING DRILL

The "Chicago" bonding drill, embodying several improved features, has recently been placed on the market. This machine is held rigidly to the rail by means of an eccentric cam, which also serves to withdraw the bit from the rail without reversing the movement of the handle or changing into another gear. By pulling up the lever directly over the rail the bit is automatically withdrawn, and the drill can then be tilted backward on the hinged foot plate. This plate is easily removable, allowing a man to carry the drill without the foot plate striking his leg.

This drill is chain-driven and has a two-speed uniform feed and reverse, both speeds being controlled by a small lever under the operator's foot. The thrust bearing is an extra large ball bearing, all others being steel in bronze. The driving gears are enclosed in a housing, allowing them to be run in oil.

The drill can be furnished with one of three feed speeds: slow, for very hard rails; medium, for standard work, and fast, for drilling relatively soft steel. It is also furnished with three styles of chucks, one with a set screw to hold 9-32-in. standard track drills; another, an adjustable chuck

The "Chicago" Bonding Drill.

to take round shank or slabbed drills up to 3.8 in. in diameter, and a third, a special chuck to hold flat shank drills.

The machine is 26 in. high, which increases the convenience of operation, and weighs 30 lb. It is manufactured by the Chicago Railway Signal & Supply Company, Chicago.

FOUNDATION LOADING FOR A 150-TON TRACK SCALE

Many installations of track scales have failed to give satisfaction because the requirements in the design of the foundations were not thoroughly analyzed. A properly designed foundation will absorb all vibration of the scale mechanism and keep it in alinement, while a lighter foundation soon begins to settle in varying amounts, thereby giving incorrect weights before the losses are discovered. A distorted foundation may be temporarily leveled up, but the original error cannot be entirely overcome. In a paper read before the recent meeting of the National Association of Scale Experts in Chicago, Eugene Motchman, chief engineer of the Standard Scale & Supply Company, Pittsburgh, Pa., discussed the distribution of loads on a 150-ton, 50-ft., 4-section scale and emphasized the points to be considered in designing the foundation as shown in the following abstract.

Four cases of loading were considered: (1) a 50-ton gondola car on the center of the scale, 2) the same car with one truck over the second support, (3) two such cars coupled in train order with their coupling over the second support, and (4) a 2-8-0 locomotive weighing 195 tons, with the drivers centered over the second support. The assumed wheel loads were 20,000 lb. for the gondola cars and 27,500 lb. on each engine driver. The resulting reactions in the four main levers on each half of the scale for each of the four loadings are as follows: (One) 1, 15,241 lb.; 2, 24,759 lb.; 3, 24,-

759 lb.; 4, 15,241 lb. (Two) 1, 3,224 lb.; 2, 33,541 lb.; 3, 12,754 lb.; 4, 30,481 lb. (Three) 1, 13,482 lb.; 2, 52,989 lb.; 3, 14,772 lb.; 18,757 lb. (Four) 1, 28,610 lb.; 2, 79,489 lb.; 3, 55,194 lb.; 4, 31,957 lb.

As shown in Fig. 1, these reactions are carried from the track rails through the I-beam supports to the main levers "M" at the points "b." These main levers transmit the load at their ends "c" to the upper system of levers "O" and "I." The main levers are supported at the points "a" on the piers "K," the length "a-c" being four times "a-b." On account of

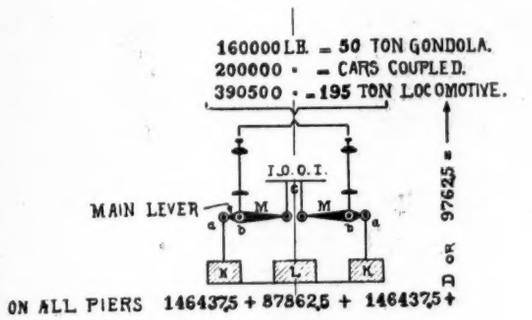


Fig. 1.

this multiplication in these levers, three-fourths of this load is carried by the piers "K" and one-fourth transmitted to the upper system of levers. The piers therefore must be designed for three-fourths of the maximum reaction in any main lever shown by the assumed loading. This maximum reaction occurs on the second support under the locomotive loading, amounting to 79,489 lb. The pier therefore carries 59,616 lb. This maximum loading could never be realized on the end piers, but by making them all uniform a desirable allowance for impact at the ends is provided.

The determination of the reaction on the center piers "L" is somewhat more complex. The load received by the longitudinal levers in the upper system is transmitted as shown in Fig. 2. The loads are applied at the points "b," the levers

15,241 lb. on the first support under the first loading when applied to the main lever causes a downward pull at "c" of one-fourth this amount or 3,810 lb. As the main levers from opposite sides act together on the upper levers, the pull at "b" of the outer lever "O" in Fig. 2, under the first loading, is 7,620.5 lb. as shown. These levers have a multiplication

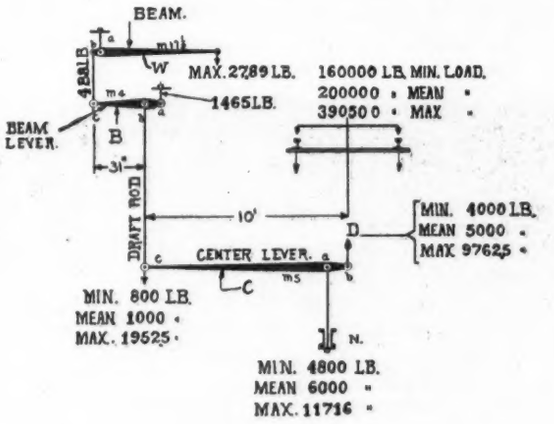


Fig. 3.

of 10, so that the end piers receive a maximum load equal to nine-tenths of the maximum pull at "b." The maximum loading, which occurs when the locomotive is on the scale, is 14,305 lb. for one end and 15,978 lb. for the other, resulting in pier reactions of 12,874.5 lb. and 14,380.7 lb., respectively. These are not the maximum loads to which these piers may be subjected, however, as the reaction would increase as the drivers approach the end of the scale. For simplicity and safety these end piers should be designed with the same section as the center piers on which the load is increased by the accumulation of the loads on the outer and inner levers being transferred to the center lever at "D." The maximum reactions on these center piers "L" as shown in Fig. 2 are 46,579.9 lb. and 33,552.4 lb. In cases where the span is more

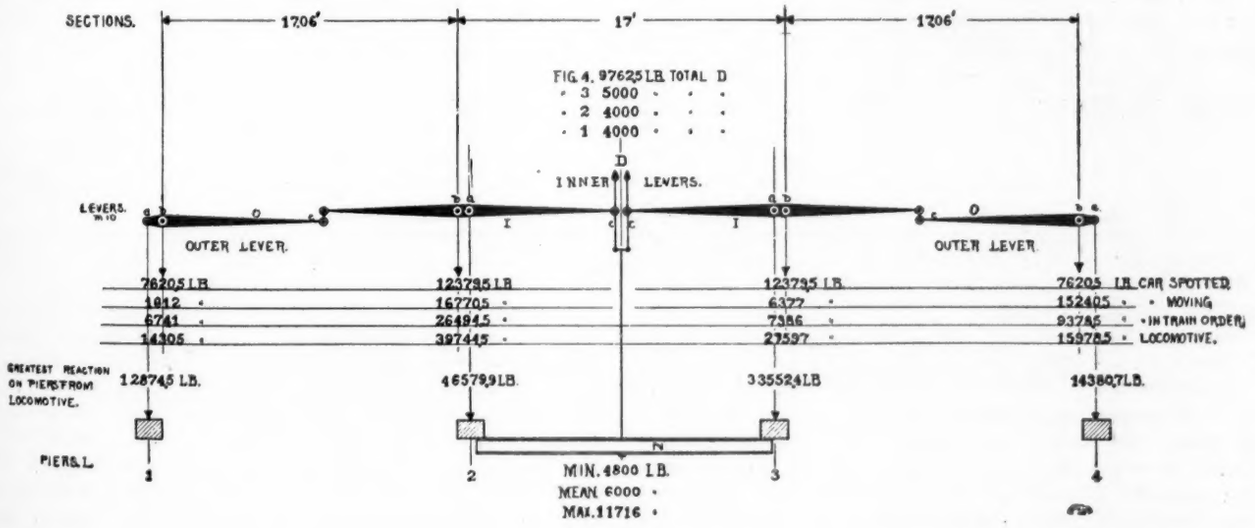
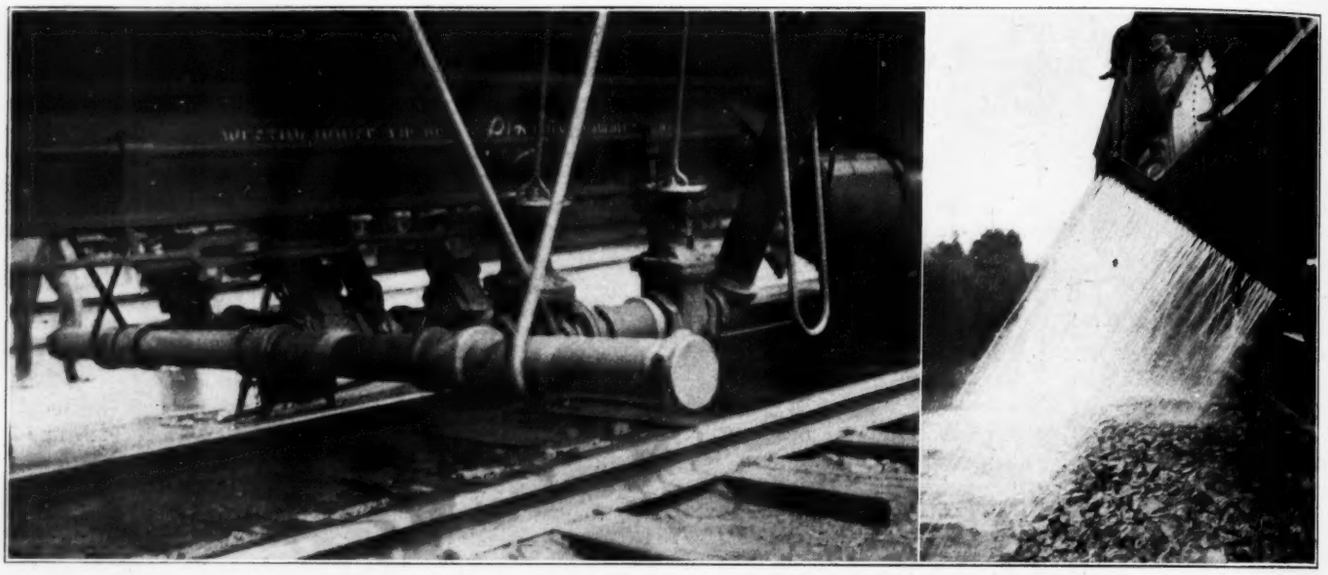


Fig. 2.

are supported on the piers "L" at the points "a" and the loads are transmitted at the points "c." The accumulation of the loads on the inner levers "I" is transmitted to the center lever "C" at the point "D." As shown in Fig. 3, this load "D" is transmitted to the draft rod, resulting in an upward pull on the channels "N" under the second and third piers equal to six-fifths of the load. Fig. 2 shows the load transmitted by the main levers to the upper levers for each of the four assumed cases of loading. For instance, the reaction of

than 17 ft., it may be more economical to set the channels "N" parallel to the center lever and imbed their ends under the surrounding wall and floor of the pit. In this case the total weight of the channels, floor and vertical walls should exceed the maximum upward pull. The surrounding wall carries the rigid deck upon which the dead rails are placed and should be designed to carry the maximum load to be placed on this deck and also to resist the action of frost and side pressure from adjacent tracks. A minimum wall thickness of

30 in. is recommended. The same thickness should be used for the end walls on account of the necessity for taking care of the impact. The use of 18-in. walls is considered good practice under the weigh house. The design of the floor of the foundation depends largely on the character of the soil. If solid rock is near the surface the piers may be built directly on it. In all other cases the bearing pressure of the soil must be determined and the piers dimensioned accordingly. The common practice at present in designing pits for heavy track scales is to design the floor as a concrete mat supporting the piers raised slightly above the level of the floor. In climates such as those in the United States south of Chicago and north of Oklahoma, the depth of foundations from base of rail to bottom of mat should never be less than 8 ft. and this dimension should be increased in northern climates and reduced in tropical countries if the scale mechanism does not require this depth.



Details of Latest Sprinkling Equipment, Showing Five Valves for Controlling Chemical and Adjustable Extension Arm for Spraying Ballast Shoulder.

IMPROVEMENTS IN ATLAS WEED-KILLING METHOD

Two important improvements have been made by the Atlas Preservative Company, New York City, in its method of applying the Atlas "A" chemical compound for killing track vegetation. The first of these is in the design of a sprinkling equipment to apply the compound in varying quantities across the track as it is needed. In many cases the center of the track is sterile or nearly so, while at the tie ends or on the ballast shoulders a considerable quantity of vegetation may exist. For the most economical treatment it is necessary, therefore, to use varying quantities both along and across the track. The sprinkling arms designed to accomplish this purpose can be made in any length and are divided into five sections, each controlled by an independent valve. These valves are operated from the running board by means of valve stems. The extension arm which sprays the portion outside of the rail is supported in the lowered position by a U-brace, and as it works on a loose thread it may be raised and lowered by a chain attached to its outer end. This is convenient in passing obstructions or in elevating the arms to force the mixture out over the ballast shoulder. The sprinkling equipment consists of one or more tank cars fitted with spraying apparatus and all necessary accessories for handling the chemical, the operation of the train being superintended by an employe of the Atlas Company. The size of the equipment is designed to spray from 8 to 20 miles, so that water for dilution may be obtained with a minimum train service. The speed of treating the vegetation is from 15 to 20 miles per hour.

A serious objection to the chemical method of treating vegetation in the early stages of the development of this system was the danger of cattle grazing on the treated area with fatal results. A compound to prevent cattle from eating vegetation so treated has been developed and in the early experiment was mixed with the Atlas "A". It was soon found, however, that the chemical action reduced the efficiency of the "cattle proofer" and to eliminate this action the special compound is now shipped and applied in a separate tank car. It is stated that the results with this new compound have been very satisfactory. The greater part of 743 miles of track on the Southern Railway was treated without harm to live stock and, in addition, 50 miles on the Seaboard Air Line and about 250 miles on the Chicago & North Western were treated with equally satisfactory results.

WESTERN AUTOMATIC DUMP CAR

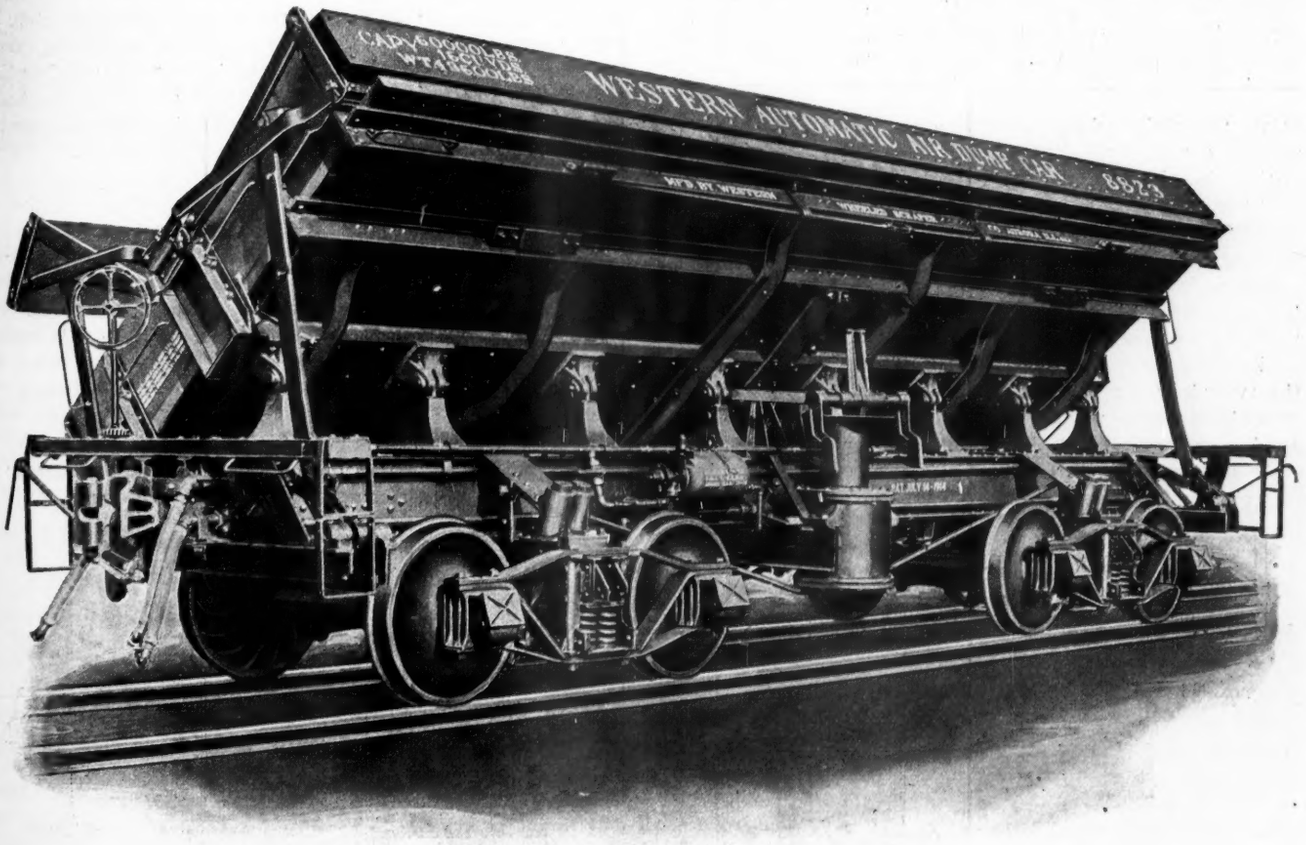
The Western Wheeled Scraper Company, Aurora, Ill., has perfected an automatic air dumping apparatus for application to the Western dump cars of standard design, and after thorough test the cars so equipped are now being placed on the market. As the use of side chains is strongly favored by some men, provision is retained on these cars for the application of such chains as on the other types of cars manufactured by this company. The new automatic device locks the bed in the upright position when loading and hauling the cars, and allows them to be dumped either by the engineer from the cab or by pulling a lever at each car. In the former case the engineer can unlock, dump, right and lock the entire train from the engine, effecting a saving in labor and time, as well as eliminating the chances for personal injury to the men.

The power for dumping these cars automatically is furnished by two vertical cylinders, one on each side, located centrally between the trucks, attached to the draft beams and supported by a truss rod fastened to the end of the bolsters. On the 20-yd. car the cylinders are 20 in. in diameter and have a stroke of 17 in., lifting about 16 tons at 100-lb. air pressure. By the use of this short stroke it is possible to place the apparatus so high on the car that

the possibility of obstructions on the track striking the mechanism is largely obviated and the chances for damage to the apparatus in case of derailment are reduced. The short stroke cylinder is made possible by the use of an extension on the upper end of the piston. The first movement of the piston throws this extension up against the car bed, and at the same time unlocks the bed, which is normally held in position by bars that lift the doors at the four corners of the car. The lower ends of these bars are attached to cranks fastened to the end draft beam cross sills, which are on dead centers in the locked position. These cranks are connected to a rocker shaft extending along the draft beams to the cylinders, so that the first 4 in. of the piston movement rocks this shaft and pulls the crank off the dead centers, thus unlocking the bed and permitting it to tilt and discharge its load. The same movement of the piston pulls the extension of the opposite piston in toward the draft beam, allowing the bed to descend without coming in contact with that piston extension. This inward movement of the opposite piston extension puts the automatic unlocking device on that side of the car out of operation, so that it remains locked. The continuation of the piston stroke performs the act of dumping the bed. To right the bed after dumping, air is admitted to the opposite cylinder, causing the roller in the upper end of the piston and at the lower end of the extension to come in contact with the car bed and move it half as far as when the piston extension is up against the bed. As this side of the bed remains locked, the movement is stopped when the bed has reached the carrying position. There is sufficient play to admit of slight oscillation when the car is in motion.

The air for dumping these cars is pumped directly into the train line from the engine, the system commonly known as "straight" air, in distinction to automatic air, the system used for air brakes. The advantages of straight air for operating this dumping mechanism are that the cars are not all dumped at one time, as would be the case with automatic air, and a saving in air is effected since a valve in the train line automatically cuts the air off when the piston has reached the dumping position. The distribution of the load over the bed of the car will rarely be the same on any two cars in a train, and the amount of power required to dump the car therefore varies with each car. With the Western automatic apparatus, if the car is loaded so that it will dump by gravity when unlocked, no air will be used. A car requiring a small amount of air will dump quickly and one requiring more air will dump later as the pressure increases. Thus the cars will dump in succession in accordance with the amount of air required, no matter where they are located in the train. This method of dumping greatly lessens the jar on the trestle as compared with the dumping of a complete train of loaded cars simultaneously.

The new automatic car has all of the features of the Western dump cars now in use. It is equipped with the automatic pivoted side doors which rise out of the way of the load as the bed is tilted and give a large opening for discharge of the material. The hinge sockets riveted to the draft beams are each provided with a slotted opening into which the flat connecting bar drops, which in turn is pivoted on the hinge casting attached to the car bed. The bed rests on the center castings, or pedestals, and not on the pins which hold the connecting bar in place. The hinge rocks on the pedestal, forming an ample bearing. The cars are equipped with the safety devices required by the Interstate Commerce Commission and conform with the M. C. B. specifications.



Sixteen-Yard Automatic Dump Car, with Steel Ends and Doors and Wooden Floor.

PROTECTION OF STEEL FROM LOCOMOTIVE GASES

The Chicago, Rock Island & Pacific has just completed the replacing of three spans of a highway bridge over its tracks near the Burr Oak yard, just south of Chicago, which, on account of limited clearance, necessitated careful attention to the method of protecting the steel in the lower part of the girders and in the floor beams and stringers from the destructive action of locomotive blasts and gases. In accordance with the almost universal practice at present under similar conditions a concrete encasement was adopted, the plans at first providing for the stringers to be enclosed by forms to make their encasement monolithic with the roadway and sidewalk slabs. As the main girders had a clearance of only 20 ft. 3 in. above the track and the floor beams 20 ft. 6 in., it was decided to encase the portion of these beams below the slabs with reinforced gunite on account of the greater density and impermeability of this concrete grout applied by the cement gun process. The contract for all concrete work was let to the Cement Gun Construction Company, Chicago, to be handled under the supervision of I. L. Simmons, bridge engineer of the Rock Island.

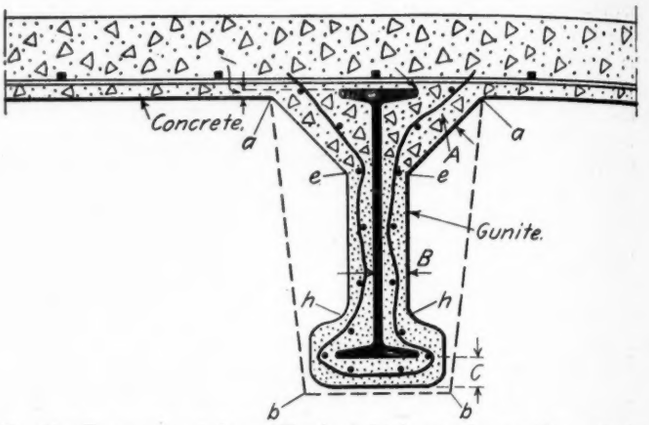
COMPARATIVE WEIGHT AND COST OF CONCRETE AND GUNITE BEAM ENCASEMENT.

Size of beam.	Weight of poured encasement	Weight of Gunite encasement	Per cent saved	Cost of poured encasement	Cost of Gunite encasement	Per cent saved	Dimensions A	B	C
8 in.	82 lb.	38 lb.	54%	$0.35	$0.33	6%	1½ in.	1½ in.	2 in.
10 in.	102 lb.	42 lb.	59%	.43	.41	5%	2 in.	1½ in.	2 in.
12 in.	128 lb.	64 lb.	50%	.55	.48	13%	2½ in.	1½ in.	2 in.
15 in.	187 lb.	89 lb.	52%	.81	.67	17%	3 in.	1½ in.	2 in.
18 in.	228 lb.	94 lb.	59%	.98	.64	35%	3½ in.	1½ in.	2 in.
20 in.	260 lb.	122 lb.	53%	1.12	.86	23%	3½ in.	1½ in.	2 in.

It was found that the building of the forms for encasing the stringers was a considerable part of the cost of the entire work, as 105 separate forms were required for the full length stringers in addition to a number of fractional lengths on the two skewed spans. At the suggestion of the contractor this difficult form work was eliminated by substituting gunite for the concrete around these stringers.

As shown in the accompanying cross section, the beams supporting the sidewalk slabs were encased in concrete poured with those slabs because the simple design of the forms and the ease with which they could be supported on the sidewalk brackets made that method the least expensive. The floor stringers were first wrapped with poultry netting and then covered with 1¾ in. of gunite up to the bottom line of the floor slabs. When this had set, the flat floor slab forms were supported on the gunite-encased lower flanges of the stringers and the slabs poured in the usual way.

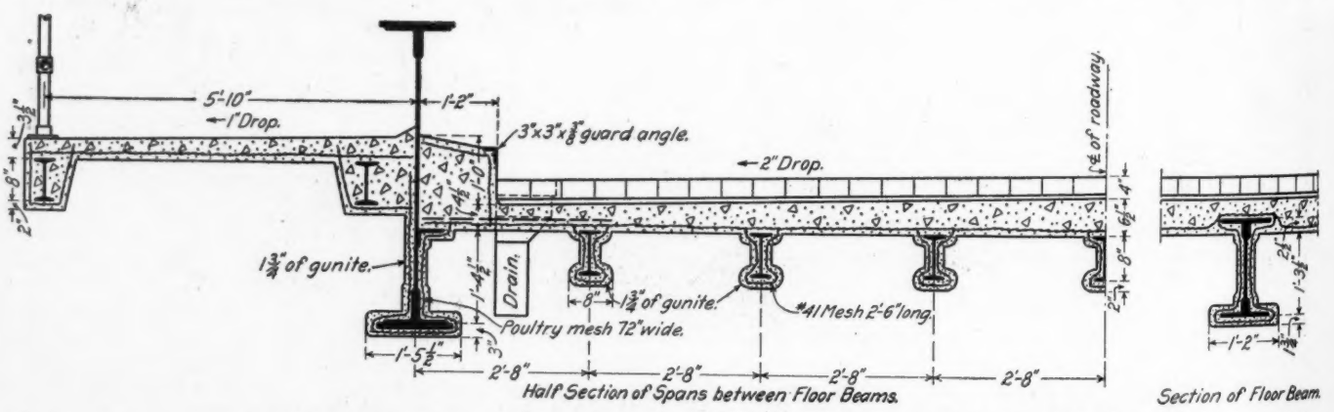
The following advantages are claimed by the Cement Gun Construction Company for this type of construction as applied to any floor beams or stringers subject to the direct action of blasts and gases. First, it forms a superior encasement, the gunite being at least 50 per cent more dense than concrete and to that extent better able to withstand the blast action. Gunite is also more impervious to gases, forming a better protection for the steel against rust than ordinary concrete. Second, a saving in cost can be effected and in addition economies in form work for slabs supported on these beams are possible through the use of the lower flanges to support the forms. Third, the dead weight of the floor system is materially reduced.



Gunite Encasement for a Typical Stringer Supporting a Concrete Slab.

One of the accompanying illustrations shows a typical floor slab and stringer with gunite encasement of the supporting member and in dotted lines the usual concrete encasement. In the former design the gunite is carried up to "e e," where it is sloped in to the beam on approximately a 45-deg. angle. The concrete supported on this gunite is thoroughly bonded to it and is sloped outward at an angle of about 45 deg., so that the points "a a" are practically the same in either design, giving the slabs substantially the same support and the same clear span.

The advantages which this type of construction has over a poured concrete encasement in weight and cost are shown in the accompanying table, computed by the above company, which compares these items per running foot for beams from 8 in. to 20 in. in depth, giving also the standard thickness of gunite. In this table the cost is based on the assumption that concrete for this type of construction costs $0.60 per cu. ft. and gunite $0.18 per sq. ft. 1½ in. thick. While these costs vary somewhat they are accurate enough for purposes of comparison.



Details of Encasement of Girders, Floor Beams and Stringers of Chicago, Rock Island & Pacific Bridge at Burr Oak, Ill.